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## **Humboldt Bay Area Plan Communities at Risk Strategic Sea Level Rise Adaptation Planning Report**

Aldaron Laird

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# Humboldt County Humboldt Bay Area Plan



King Salmon King Tide Flooding 9.4 feet NAVD 88, January 2017

## Communities at Risk Strategic Sea Level Rise Adaptation Planning Report

November 2019

# HUMBOLDT COUNTY

## Humboldt Bay Area Plan

### Communities at Risk Strategic Sea Level Rise Adaptation Planning Report

Prepared By

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Trinity Associates

November 2019

## **Acknowledgements**

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**DISCLAIMER:** The following Communities at Risk - Strategic Sea Level Rise Adaptation Planning Report for King Salmon, Fields Landing, Fairhaven and Finntown was prepared for Humboldt County. All statements are the sole responsibility of Aldaron Laird of Trinity Associates and do not necessarily reflect the views or policies of Humboldt County. This report is for planning purposes and is not a substitute for site-specific sea level rise vulnerability assessments and adaptation planning.

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## Glossary

This report relies in part on terms and definitions that were derived from the California Coastal Commission (CCC) Sea Level Rise Policy Guidance, adopted August 12, 2015.

**Adaptation:** Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which minimizes harm or takes advantage of beneficial opportunities.

**Adaptive capacity:** The ability of a system to respond to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, and to cope with the consequences.

**Backwater or Backwater flooding:** Upstream flooding caused by downstream conditions such as channel restriction or high tide blocking high river flows from entering estuaries.

**Coastal-dependent development or use:** Any development or use which requires a site on, or adjacent to, the sea to be able to function at all.

**Coastal resources:** A general term used throughout the Guidance to refer to those resources addressed in Chapter 3 of the California Coastal Act, including beaches, wetlands, agricultural lands, and other coastal habitats; coastal development; public access and recreation opportunities; cultural, archaeological, and paleontological resources; and scenic and visual qualities.

**Development:** On land, in or under water, the placement or erection of any solid material or structure; discharge or disposal of any dredged material or of any gaseous, liquid, solid, or thermal waste; grading, removing, dredging, mining, or extraction of any materials; change in the density or intensity of use of land, including, but not limited to, subdivision pursuant to the Subdivision Map Act (commencing with Section 66410 of the Government Code), and any other division of land, including lot splits, except where the land division is brought about in connection with the purchase of such land by a public agency for public recreational use; change in the intensity of use of water, or of access thereto; construction, reconstruction, demolition, or alteration of the size of any structure, including any facility of any private, public, or municipal utility; and the removal or harvesting of major vegetation other than for agricultural purposes, kelp harvesting, and timber operations which are in accordance with a timber harvesting plan submitted pursuant to the provisions of the Z'berg-Nejedly Forest Practice of 1973 (commencing with Section 4511).

**Environmentally Sensitive Habitat Area (ESHA):** Any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments.

**Erosion:** The wearing away of land and removal of shoreline, beach or sand dune sediments by wave action, high tides, tidal currents, and overtopping shoreline structures such as dikes.

**Flood (or Flooding):** Refers to normally dry land becoming temporarily covered in water, either episodically (e.g., storm or tsunami flooding) or periodically (e.g., tidal flooding). Annual king tides are an example of tidal flooding of lands normally not covered by daily or monthly high tides. Coastal Hazard planning generally addresses episodic 100-year floods that have 1% probability of occurring in any year but like all floods are unpredictable as to when they might occur. Floods do recede, and flooded lands generally do dry out again.

**Inundation:** Inundation as used in this report is a form of tidal flooding. Inter-tidal areas are those lands above the lowest tide and below the highest tide elevations that periodically experience tidal inundation. Areas that are below the lowest tide elevation are submerged lands, and thus are permanently inundated. Tidal inundation datums are generally described as to their frequency of occurrence and elevation, such as daily mean low or high water (MLW and MHW); mean monthly and mean annual maximum high water are additional tidal datums (MMMW and MAMW). Tidal inundation is very predictable. Tide charts are published each year that identify when, and how low or high, the tides are expected reach common daily tidal datums: mean lower low water (MLLW), MLW, MHW, and mean higher high water (MHHW). Inundation maps used in this report depict areas that could be inundated by MMMW under various sea level rise scenarios, absent storm surge or wind wave conditions.

**Mean sea level:** The average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides.

**Relative sea level:** Combination of regional sea level measured by a tide gauge and vertical land motion trends of the land upon which the gauge is situated.

**Risk:** Commonly considered to be the combination of the likelihood of an event and its consequences – *i.e.*, risk equals the probability of climate hazard occurring multiplied the consequences a given system may experience.

**Sea level:** The height of the ocean relative to land; tides, wind, atmospheric pressure changes, heating, cooling, and other factors cause sea level changes.

**Sea level change/sea level rise:** Sea level can change, both globally and locally, due to (a) changes in the shape of the ocean basins, (b) changes in the total mass of water and (c) changes in water density. Factors leading to sea level rise under global warming include both increases in the total mass of water from the melting of land-based snow and ice, and changes in water density from an increase in ocean water temperatures and salinity changes. Relative sea level rise occurs where there is a local increase in the level of the ocean relative to the land, which might be due to ocean rise and/or land level subsidence.

**Sea level rise impact:** An effect of sea level rise on the structure or function of a system.

**Sensitivity:** The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., climatic or non-climatic stressors may cause people to be more sensitive to additional extreme conditions from climate change than they would be in the absence of these stressors).

**Shore protection:** Structures or sand placed at or on the shore to reduce or eliminate upland damage from wave action or flooding during storms.

**Shoreline protective devices:** A broad term for constructed features such as seawalls, revetments, riprap, earthen berms, cave fills, and bulkheads that block the landward retreat of the shoreline and are used to protect structures or other features from erosion and other hazards.

**Shoreline vulnerability rating:** A quantitative measure of vulnerability that uses combinations of shoreline attributes (cover type and relative elevation to modeled MMMW) to rank shoreline segment's vulnerability to erosion and/or overtopping due to extreme tides, storm surges, and sea level rise. (Laird and Powell 2013)

**Still water level:** The elevation that the surface of the water would assume if all wave action was absent.

**Storm surge:** A rise above normal water level on the open coast due to the action of wind stress on the water surface. Storm surge resulting from a hurricane also includes the rise in water level due to atmospheric pressure reduction as well as that due to wind stress.

**Subsidence:** Sinking or down-warpage of a part of the earth's surface; can result from seismic activity, changes in loadings on the earth's surface, fluid extraction, or soil settlement.

**Tectonic:** Of or relating to the structure of the earth's crust and the large-scale processes that take place within it.

**Tidelands:** Lands which are located between the lines of mean high tide and mean low tide.

**Vulnerability:** The extent to which a species, habitat, ecosystem, or human system is susceptible to harm from sea level rise impacts. More specifically, the degree to which a system is exposed to, susceptible to, and unable to cope with, the adverse effects of sea level rise, and tidal extremes.

## 1.0 Executive Summary

While updating the Humboldt Bay Area Plan (HBAP), a component of Humboldt County's Local Coastal Program (LCP), the County has been investigating the potential for impacts from sea level rise to the Humboldt Bay region. Sea level rise vulnerability assessment documents prepared for the HBAP can be found at the County's LCP Update website: <https://humboldt.gov.org/1678/Local-Coastal-Plan-Update>

Located in the area of unincorporated Humboldt County covered by the HBAP are three communities that are vulnerable to and at risk from sea level rise of 3.3 feet (1.0 meter) and are the focus of this adaptation planning report: King Salmon, Fields Landing, and Fairhaven (which includes the area referred to as Finntown). Potential sea level rise impacts these communities could be exposed to include: shoreline erosion, tidal inundation, flooding from rising groundwater in response to sea level rise, backwater flooding during stormwater runoff and high tides, and salt water intrusion of individual septic/wastewater systems. The California Ocean Protection Council's (OPC) latest high projection for sea level rise (OPC 2018) is 3.3 feet by 2065.

Humboldt County's general approach to sea level rise adaptation is to protect critical assets for as long as it is physically and economically feasible, and to simultaneously and incrementally plan for future retreat if and when protection is no longer an option. Overarching sea level rise adaptation goals and strategies generally include protecting assets from sea level rise impacts, modifying assets to accommodate these impacts, relocating existing assets to areas that will not be impacted, and avoiding siting new assets in areas that will be impacted by rising sea levels. Education of the potentially affected public, businesses, and agencies is an important component of any sea level rise adaptation strategy. The County anticipates the need for a mix of protection, accommodation, and retreat strategies, and hybrids thereof, in order to implement the County's general approach to sea level rise adaptation.

While the intent of the County's LCP sea level rise adaptation policies that are currently being developed is to address sea level rise impacts, the County lacks the capacity to unilaterally implement sea level rise adaptation strategies for assets that are privately owned or that are the responsibility of another agency. Adaptation to sea level rise will require coordination, collaboration, and cooperation between all stakeholders.

This adaptation planning report describes the characteristics of each of these three HBAP communities directly at risk from sea level rise, the sea level rise impacts they may be exposed to, a range of suitable adaptation goals, strategies, and solutions, and recommended adaptation strategies and solutions.

## King Salmon

Historically, the shoreline at Bhune Hill at King Salmon has experienced the greatest amount of wave-induced erosion on Humboldt Bay; the shoreline eroded inland approximately 1,480 feet between 1890 and 1950. The most exposed shoreline segments in King Salmon have been fortified with rock slope protection/sea wall, rock jetties, and barrier dune system. These fortifications will need to be enhanced to continue to protect the community of King Salmon, and Pacific Gas & Electric Company's (PG&E) electrical power generating facilities and nuclear Independent Spent Fuel Storage Installation (ISFSI).

King Salmon, with its network of tidal canals and location across from the Humboldt Bay entrance, is more exposed to shoreline erosion and tidal-induced flooding than most coastal communities. With a mean higher high water (MHHW) elevation increase of 3.3 feet (1.0 meter), nearly all of King Salmon will be tidally inundated daily. PG&E's Humboldt Bay Generating Station (HBGS) in King Salmon would be tidally inundated by mean annual maximum water (MAMW, commonly referred to as king tides) with 3.3 feet (1.0 meter) of sea level rise. Current high projections indicate that this could occur by 2065 (OPC 2018). With just 1.6 feet (0.5 meters) of sea level rise, king tides will tidally inundate the entire community of King Salmon, possibly as soon as 2040 (OPC 2018). King Salmon is already experiencing nuisance flooding by king tides. The community of King Salmon is also vulnerable to rising groundwater and saltwater intrusion in response to sea level rise of 1.6 to 3.3 feet (0.5 to 1.0 meters).

Sea level rise adaptation goals applicable to King Salmon would sustain the use and value of the community for as long as feasible and protect regional infrastructure located in this community. There are various adaptation options in King Salmon for implementing the sea level rise adaptation strategies of protecting assets, modifying assets to accommodate impacts, relocating existing assets to areas that will not be impacted, and avoiding siting new assets in areas that will be impacted.

In the short-term, 20 to 45 years assuming current sea level rise predictions (OPC 2018), new tidal barriers may be needed and existing barriers enhanced, while buildings in King Salmon would need to be elevated as would the surface streets that provide access to the community. If the community of King Salmon is to exist with the 3.3 feet (1.0 meter) of sea level rise currently predicted by OPC to occur by 2065, a more aggressive redevelopment adaptation strategy and solutions will need to be designed, permitted, funded, and implemented. In the long-term, if nothing is done to accommodate sea level rise, there is the risk that buildings and developments in King Salmon would need to be abandoned.

Pacific Gas & Electric Company's HBGS would need to be relocated from King Salmon in the long-term or by 2065 based on current OPC predictions, when king tides could inundate the facility. Of critical concern in the long-term is maintaining and enhancing



protection of the bluff in front the nuclear ISFSI on Buhne Hill until such time that it can be moved away from the coast.

The community of King Salmon is nearly entirely in the Coastal Commission's retained coastal development permit jurisdiction. Therefore, the success of developing and implementing any adaptation strategy will require the collaboration and cooperation of the Commission and County.

## Fields Landing

Fields Landing has an elevated waterfront consisting of mostly abandoned coastal-dependent industrial (CDI) lands, a bulk cargo dock, a public boat launch facility and a marine repair dry dock. The residential/commercial portion of the community resides on low-elevation (8 feet NAVD 88 or less) former salt marsh, behind the waterfront and railroad grade. Salt water currently rises through storm drains, flooding surface streets and intersections in Fields Landing during king tides.

With just 1.6 feet (0.5 meters) of sea level rise and current shoreline conditions, most of the community would likely be tidally inundated several times a year by 2040 during king tides (OPC 2018). When sea level rise reaches 3.3 feet (1.0 meter) by 2065 (OPC 2018), the residential portion of the community could be tidally inundated daily by MHHW and the waterfront of Fields Landing could be tidally inundated once a month by the Mean Monthly Maximum Water (MMMW). Sea level rise hazards and impacts that the community of Fields Landing may be exposed to include: tidal inundation, backwater flooding, rising groundwater flooding, and salt water intrusion.

An abandoned railroad grade traverses the community, dividing the industrial waterfront from the residential areas. The railroad provides a pathway for tidal inundation of the low-lying residential/commercial portion of Fields Landing where the railroad grade reaches the bay on the north and south end of the community. Inundation of the community could occur via this pathway with 1.6 feet (0.5 meter) of sea level rise during MMMW by 2040 (OPC 2018), while king tides could also breach the waterfront at multiple locations and tidally inundate the low-lying residential and commercial areas to the east. When sea level rises to 3.3 feet (1.0 meter) by 2065 (OPC 2018), nearly all developed areas of Fields Landing could be chronically inundated by MMMW of 11.0 feet (NAVD 88).

Groundwater elevation likely fluctuates between mean sea level of 3.4 feet (NAVD 88) and MHHW of 6.5 feet (NAVD 88). Most of the residential/commercial area of Fields Landing is 6 to 8 feet (NAVD 88) in elevation, and groundwater could be within 1 to 2 feet of the surface. In several areas, there is open water in the residential portion of the community, which indicates groundwater is at the surface. As sea levels rise, ground water elevation will also rise. Groundwater would likely emerge on the surface of most of the residential/commercial area of Fields Landing by approximately 2040 based on the OPC's current high sea level rise projection for 1.6 feet (0.5 meter) (OPC 2018).

Sea level rise adaptation goals applicable to Fields Landing would sustain the use and value of the community for as long as feasible. Protection of the community's built-out environment exposed to sea level rise is a high priority short-term (20-45 years) strategy.

There are adaptation measures that can be applied to implement the sea level rise adaptation strategies: protecting assets, modifying development to accommodate impacts, relocating existing assets to areas that will not be impacted, and avoiding siting new assets in areas that will be impacted. In the short-term, 20 to 45 years, new tidal barriers could be constructed and low-lying inundation pathways filled to prevent tidal inundation of the low elevation residential community. However, the existing low elevation residential area would remain at risk of being flooded by emerging groundwater. If the community of Fields Landing is to exist beyond 2065 when 3.3 feet (1.0 meter) of sea level rise is predicted (OPC 2018), aggressive redevelopment adaptation strategies and solutions will be needed such as elevating streets, rebuilding structures on pilings, or relocating the residential community to the higher elevation underutilized waterfront currently designated for CDI use. In the long-term, if nothing is done to accommodate or relocate in response to sea level, there is a risk that buildings and developments may be abandoned.

The community of Fields Landing is in a unique position in that there is a potential opportunity to relocate to a higher elevation environment along its waterfront and enhance its waterfront protection characteristics in response to sea level rise. However, the low-lying residential community of Fields Landing which is at risk from sea level rise in the short-term is in the County's coastal development permit jurisdiction and the higher elevation waterfront is in the state's retained permit jurisdiction. Therefore, the success of developing and implementing any adaptation strategy will require collaboration and cooperation between the Commission and County.

## Fairhaven and Finntown

The general community area known as Fairhaven is located on the North Spit on the western shore of Humboldt Bay. The community is located east of New Navy Base Road and south of Bay Street. Humboldt Bay's main navigation channel is adjacent to Fairhaven. A former pulp mill, which is now the Fairhaven Business Park with an unused bulk cargo dock and several commercial warehouses, fronts the Bay shoreline in Fairhaven. The residential area of Fairhaven is located westerly of the Fairhaven Business Park adjacent to undeveloped land designated for industrial use. There is a commercial fishing enclave on the north shore of Fairhaven historically referred to as Finntown.

The main residential area of Fairhaven, with 65% of its lots undeveloped, is bounded on two sides by properties with an Industrial/Coastal-Dependent (MC) land use designation (one of which is zoned Public Facility, the other two zoned MC), and to the north is

property with an Industrial/General (MG) land use and zoning designation. The MC land between Park and Dupey streets in the residential area and the Bay shoreline contains low-lying seasonal wetlands. The community relies on individual wastewater septic tank/leachfield systems on lots that range in elevation between 9 and 12 feet NAVD 88.

Property planned and zoned MC (Industrial/Coastal-Dependent) along the waterfront of Fairhaven extends north including the Finntown area. Finntown is a small residential and commercial area nestled between high dunes to the west and the Bay to the east, and has a strong orientation to the Bay with an active marine repair/dry dock facility, aquaculture pier, other commercial uses, and waterfront residential parcels.

King tides do not presently flood the Fairhaven/Finntown area, but they do flood the undeveloped wetlands between the residential area of Fairhaven and the shoreline. Fairhaven is lower in elevation than Finntown and would be tidally inundated by MMMW with 3.3 feet (1.0 meter) of sea level rise, while Finntown would only experience nuisance flooding during king tides. The sandy and dune/wetland shoreline next to the residential area of Fairhaven is susceptible to shoreline erosion such as is occurring just to the south. Tidal inundation of the residential area of Fairhaven will begin to occur from the east and progress to the west starting with 1.6 feet (0.5 meters) of sea level rise. As sea levels rise, ground water elevation will also rise, and salt water intrusion may occur that will likely affect the septic tank/leachfield systems in most of the residential areas of Fairhaven and Finntown by 2040 (OPC 2018) with 1.6 feet (0.5 meter) of sea level rise when MHHW rises to 8.1 feet (NAVD 88).

Sea level rise adaptation goals applicable to Fairhaven and Finntown would sustain the use and value of these communities for as long as feasible. Protection of these communities' built-out environment exposed to sea level rise is a high priority short-term (20-45 years) strategy. Rising groundwater and salt water intrusion could significantly impact the individual wastewater systems of these communities where septic systems are already not meeting Regional Water Quality Control Board water quality objectives due to soil and ground water conditions and small lot size. Developing a regional wastewater collection and treatment system would increase the resiliency of these communities.

Protective structures could be employed in Fairhaven to prevent tidal inundation, but less so at Finntown with its marine repair/dry dock facility needing access to the navigation channel. The eastern most streets in Fairhaven could be elevated to function as tidal barriers and to maintain access to residential lots. Accommodating sea level rise could be incorporated by designing buildings on pilings or on clear stories such as has been done in King Salmon. Before sea level rise reaches 3.3 feet (1.0 meter) by 2065 (OPC 2018), Fairhaven could potentially be relocated inland to a higher elevation undeveloped area on 50 acres. Similarly, the residential and noncoastal-dependent commercial developments in Finntown could also physically relocate inland to higher ground. The potential relocation areas include property in private ownership, which complicates relocation potential.

Similar to Fields Landing, the waterfront/shoreline area of Fairhaven community area are in the Coastal Commission's retained coastal development permit jurisdiction while the inland areas of the community as well as the potential relocation sites are in the County's permit jurisdiction. Therefore, the success of developing and implementing any adaptation strategy will require collaboration and cooperation between the Commission and County.

## 2.0 Introduction

A comprehensive sea level rise vulnerability assessment was prepared for Humboldt County's HBAP jurisdiction, including at-risk communities (Laird 2018). This document can be found at the following link on the County's LCP Update website:

<https://humboldt.gov/DocumentCenter/View/62872/Humboldt-Bay-Area-Plan-Sea-Level-Rise-Vulnerability-Assessment-Report-PDF?bidId>

The County received a grant in 2017 from the California Coastal Commission to engage communities within the HBAP planning area that are at risk from sea level rise by initiating the process of educating stakeholders about their vulnerability and exploring adaptation strategies. In August 2018, two workshops were held for the four at-risk communities within the HBAP - one workshop for King Salmon and Fields Landing, and another for Fairhaven and Finntown. The County's sea level rise vulnerability assessment for these at-risk communities, *Communities at Risk from Sea Level Rise Vulnerability Assessment - King Salmon, Fields Landing, Fairhaven and Finntown (Laird 2018b)*, is available at the County's LCP Update website. This companion report, *Communities at Risk - Strategic Sea Level Rise Adaptation Planning Report*, is also posted on the County's LCP Update website, which along with these communities at risk reports, has additional sea level rise and other HBAP update information at the following link: <https://humboldt.gov/1678/Local-Coastal-Plan-Update> .

## 3.0 Community Sea Level Rise Adaptation Goals, Strategies and Solutions

Conceptually, sea level rise adaptation strategies involve protecting assets from sea level rise impacts, modifying assets to accommodate these impacts, relocating existing assets to areas that will not be impacted, and avoiding siting new assets in areas that will be impacted by rising sea levels.

The selection of an appropriate adaptation strategy needs to take into consideration the length of time that an asset might be exposed to rising sea levels. The Coastal Commission has required that proposed residential development in a flood hazard area would need to plan for extreme water elevations that could occur in 100 years. California has adopted probabilistic sea level rise projections for each of NOAA's tide gauges (OPC 2018; Table 1). The high sea level rise projection for the North Spit tide gauge by 2120 is 9.4 feet; MAMW or king tides would rise to 18.2 feet (NAVD 88), MMMW to 17.1 feet, and MHHW to 15.9 feet. The elevation of the residential portions of the four at-risk communities ranges from 6-8 feet (NAVD 88) in Fields Landing, 8-10 feet King Salmon, and 9 to 12 feet in Fairhaven and Finntown. This adaptation planning report focuses on near-term sea level projections for 2040 (1.6 feet/0.5 meters) and 2065 (3.3 feet/1.0 meters), when king tides could reach 10.4 feet and 12.1 feet.

Table 1. Ocean Protection Council's sea level rise probabilistic projections and risk aversion ratings for the North Spit tide gauge, Humboldt Bay (2018).

		Probabilistic Projections (in feet) (based on Kopp et al. 2014)				H++ scenario (Sweet et al. 2017) *Single scenario
		MEDIAN	LIKELY RANGE	1-IN-20 CHANCE	1-IN-200 CHANCE	
		50% probability sea-level rise meets or exceeds...	66% probability sea-level rise is between...	5% probability sea-level rise meets or exceeds...	0.5% probability sea-level rise meets or exceeds...	
				Low Risk Aversion	Medium - High Risk Aversion	Extreme Risk Aversion
High emissions	2030	0.6	0.5 - 0.7	0.8	1	1.2
	2040	0.9	0.7 - 1.1	1.2	1.6	2.0
	2050	1.2	0.9 - 1.5	1.7	2.3	3.1
Low emissions	2060	1.3	1.0 - 1.7	2	2.8	
High emissions	2060	1.5	1.2 - 1.9	2.2	3.1	4.3
Low emissions	2070	1.6	1.2 - 2	2.4	3.5	
High emissions	2070	1.9	1.4 - 2.4	2.9	4	5.6
Low emissions	2080	1.8	1.4 - 2.4	2.9	4.4	
High emissions	2080	2.3	1.7 - 2.9	3.5	5.1	7.2
Low emissions	2090	2.1	1.5 - 2.7	3.4	5.3	
High emissions	2090	2.7	2.0 - 3.5	4.3	6.2	8.9
Low emissions	2100	2.3	1.7 - 3.1	3.9	6.3	
High emissions	2100	3.1	2.3 - 4.1	5.1	7.6	10.9
Low emissions	2110*	2.5	1.9 - 3.3	4.2	7.1	
High emissions	2110*	3.3	2.6 - 4.3	5.2	8	12.7
Low emissions	2120	2.7	2.0 - 3.7	4.8	8.2	
High emissions	2120	3.7	2.9 - 4.9	6.1	9.4	15.0
Low emissions	2130	3	2.1 - 4	5.3	9.4	
High emissions	2130	4.2	3.1 - 5.5	6.9	10.9	17.4
Low emissions	2140	3.2	2.3 - 4.4	5.9	10.7	
High emissions	2140	4.6	3.4 - 6.2	7.8	12.5	20.1
Low emissions	2150	3.4	2.3 - 4.8	6.6	12.1	
High emissions	2150	5	3.7 - 6.8	8.7	14.1	23.0

Mitigating tidal inundation exposure frequency and duration over time will likely involve phasing implementation of several adaptation strategies, ranging from protection to relocation.

The County's LCP sea level rise policies currently under development are intended to increase the County's adaptive capacity to address sea level rise impacts. However, a fundamental consideration is the fact that the County lacks the capacity to unilaterally implement sea level rise strategies for assets that are privately owned or that are the responsibility of another agency. Adaptation to sea level rise will require coordination, collaboration, and cooperation from all stakeholders.

In the County's HBAP, the communities that are vulnerable and at risk from sea level rise of 3.3 feet (1.0 meter) are: King Salmon, Fields Landing, Fairhaven, and Finntown.



This planning report will describe the characteristics of each of these communities; the sea level rise impacts they may be exposed to; suitable adaptation goals, strategies, and solutions; and recommended adaptation strategies and solutions.

### 3.1 King Salmon

King Salmon is a community located west of Highway 101 on approximately 176 acres, although the developed area (excluding PG&E facilities) occupies just 36 acres. King Salmon is predominately a residential community with commercial recreational property and adjacent PG&E facilities on approximately 33 acres. The remainder of the community area is undeveloped open space that supports a barrier dune system and inter-tidal wetlands (Figure 1).

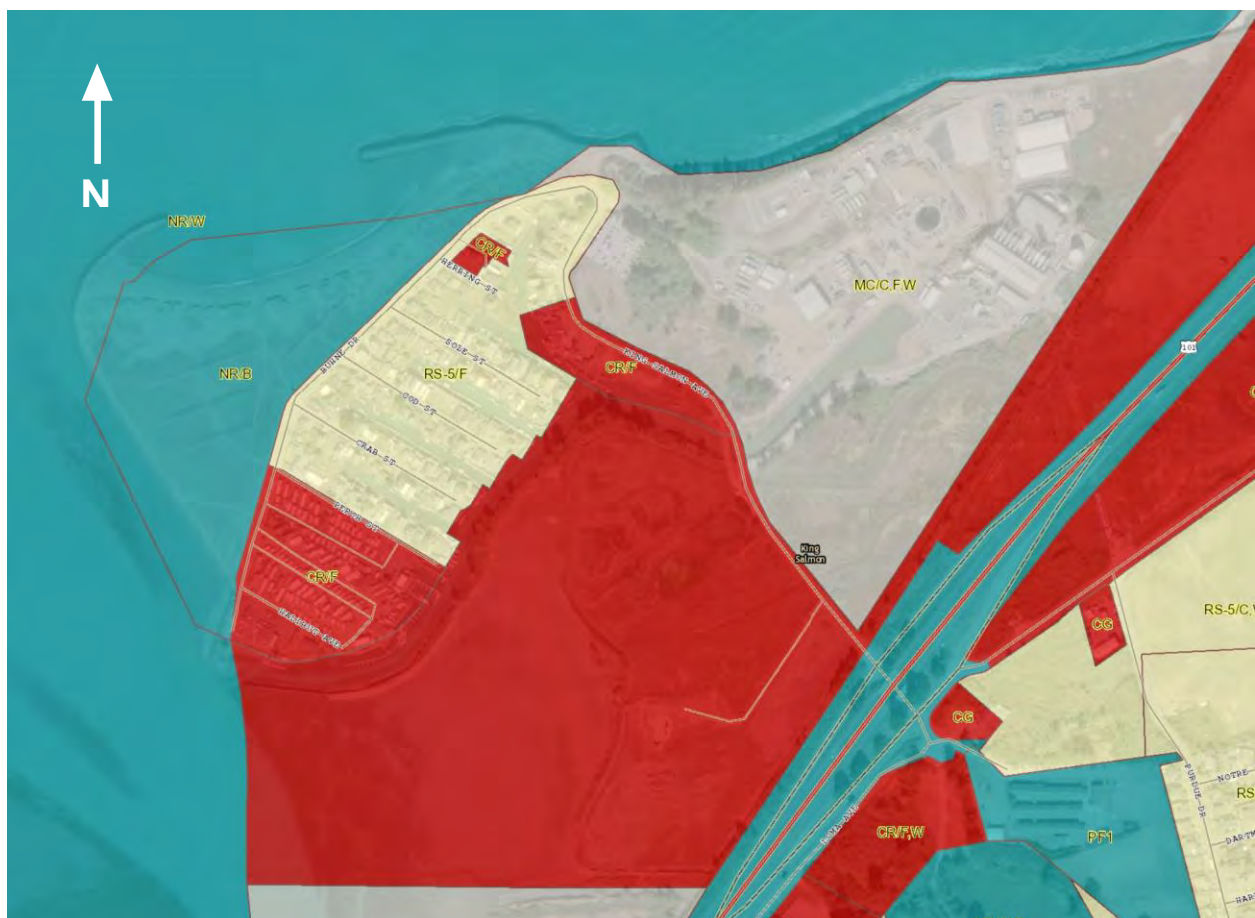


Figure 1. The community of King Salmon zoning: Residential Suburban (RS) (yellow), Commercial Recreation (CR) (red), Natural Resources (NR) (blue-green), and Industrial/Coastal-Dependent industrial (MC) (grey).

King Salmon is a unique coastal community with a network of canals that link it to Humboldt Bay (Figure 2). The shorelines of King Salmon consist entirely of artificial structures. The Humboldt Bay Harbor, Recreation and Conservation District (Harbor

District) owns and maintains a rocky south facing shoreline, two rock jetties, and a beach/dune ecosystem and recreational area on the west side of the community. PG&E's newly constructed HBGS is located in King Salmon. A critical facility on PG&E's King Salmon property is the ISFSI which stores spent nuclear fuel, and the former nuclear Humboldt Bay Power Plant. PG&E maintains a rock fortified shoreline along the north shore of the community that has also been used as a coastal trail. The North Coast Railroad Authority owns property and an abandoned railroad grade and water control structures along the eastern boundary of the community. Caltrans maintains Highway 101, including off and on ramps and water control structures, along the eastern boundary of the community. The eastern and southern shorelines of King Salmon consist of the banks of a system of canals that connect with Humboldt Bay.



Figure 2. The community of King Salmon, King Salmon Avenue, PG&E facilities (white shading), rock slope protection/jetties (red), and areas inundated by mean higher high water (6.5 feet NAVD 88 measured at the North Spit Tide Gauge).

The King Salmon community has residential property owners, trailer park and RV park owners and residents, and several commercial and coastal-dependent recreational businesses. The community is served by Humboldt County Public Works, which maintains King Salmon Avenue and its bridge, the only means of vehicular access to King Salmon and community streets. Humboldt County Public Works also maintains



several water control structures for stormwater runoff. Utility service providers include Humboldt Community Services District, which maintains three deep wells, pump stations and a distribution pipe system to deliver municipal water, and sewer lines and lift stations to convey wastewater to the City of Eureka's Elk River Wastewater Treatment Plant. PG&E provides natural gas and electricity to the community. Several private companies maintain communications infrastructure to deliver their services to the community. There are several privately owned commercial and recreational fishery service providers including a fuel dock, bilge and sewage pump-out station, 80 boat berths, EZ Landing and Johnny's Landing boat launch ramps, and many private docks.

### 3.1.1 Sea Level Rise Impacts

The King Salmon community could be significantly impacted as soon as 2065, (45 years; OPC 2018), if not before, when the current high projection for sea level rise of 3.3 feet (1.0 meter) may occur. Sea level rise hazards and impacts that the community of King Salmon may be exposed to include: shoreline erosion, tidal inundation, rising groundwater flooding, and salt water intrusion.

#### **Shoreline Erosion**

With the construction of the Humboldt Bay entrance jetties in the 1890s, high energy waves were funneled towards the high bluff of Buhne Hill. Consequently, approximately 1,480 feet of Buhne Hill eroded away by 1950 when shoreline fortified with rock slope protection (Figure 3). With erosion of Buhne Hill, the released sediment circulated in the Entrance Bay and a sand spit formed in the late 1940s. King Salmon's canals were also excavated in the late 1940s and 25-foot wide recreational fishing lots sold. This was the beginning of the community known as King Salmon.

By the 1970s, the sand spit on the western shore of King Salmon had eroded back to Buhne Drive. In response, the U.S. Army Corps of Engineers constructed two protective jetties and a barrier dune system to protect King Salmon. PG&E placed rock revetment on the north side of Buhne Hill, which also protects the community. The eastern shoreline of the community consists of a series of canal banks that are relatively sheltered and not exposed to erosion.



Figure 3. Overlay of erosion of Buhne Hill and shoreline, pre-jetty (1870 shoreline) and post-jetty construction (1940, 1970, and 2017 aerial photographs).

Buhne Hill, adjacent to King Salmon's residential development, is just a remnant of the historic topographic rise where the nuclear ISFSI is located, approximately 115 feet from the bluff and 150 from the fortified shoreline and seawall (Figure 4). Mean annual maximum water with sea level rise of 2.0 meters (6.6 feet) would rise to 15.4 feet NAVD



88 and could overtop the current rock revetment that is protecting the bluff from wave induced erosion. Based on the Ocean Protection Council's 2018 sea level rise guidance, this could occur as early as 2076 under the extreme scenario, or by 2093 under the high-risk projection.



Figure 4. Approximate distance between existing bluff on Buhne Hill and the nuclear Interim Spent Fuel Storage Site is 115 feet. The rock revetment and sea wall would be overtopped by mean annual maximum water or king tides with 6.6 feet (2.0 meters) of sea level rise, assuming the revetment is not raised.

Shoreline erosion of dikes on Humboldt Bay to the east of the King Salmon Canal was likely caused by extreme tides overtopping unmaintained dike segments, resulting in shoreline breaches that now allow tidal inundation up to King Salmon Avenue.

## Tidal Inundation

Tidal inundation of portions of King Salmon occurs now at MAMW elevations, also known as king tides, as all the tributary canals become pathways for tidal inundation of much of the residential and commercial developments (Figure 5).



Figure 5. Tidal inundation in King Salmon during a 2017 king tide of 9.4 feet NAVD 88

With just 1.6 feet (0.5 meters) of sea level rise, most of the community would likely be tidally inundated several times a year by 2040 during king tides (10.4 feet NAVD 88; OPC 2018). When sea level rise reaches 3.3 feet (1.0 meter), possibly by 2065 based on OPC 2018 high sea level rise projections, nearly the entire community and its only access road would be tidally inundated daily by mean high higher water (MHHW; 9.8 feet NAVD 88; Figure 6). A good portion of PG&E's property, facilities, sea wall and access could be tidally inundated several times a year by MAMW with 3.3 feet (1.0 meter) of sea level rise (Figure 7).





Figure 6. Tidal inundation of King Salmon and King Salmon Avenue during mean higher high water with 3.3 feet (1.0 meter) of sea level rise (9.8 feet NAVD 88), possibly by 2065 based on OPC's high sea level rise projection (OPC 2018), assuming shoreline barrier structures do not exist or are breached.



Figure 7. Tidal inundation of King Salmon Avenue, PG&E's Humboldt Bay Generating Station, former Humboldt Bay Power Plant, two access roads, and a portion of the sea wall on Humboldt Bay during MAMW or king tides with 3.3 feet (1.0 meter) of sea level rise (9.8 feet NAVD 88) by 2065, based on a high projection (OPC 2018), assuming shoreline barrier structures do not exist or are breached.

### **Rising Groundwater Flooding**

Groundwater elevation likely fluctuates between mean sea level of 3.4 feet (NAVD 88) and MHHW of 6.5 feet (NAVD 88). Most of King Salmon is less than 10 feet (NAVD 88) in elevation, and groundwater may be within 2 to 3 feet of the surface. As sea levels rise, ground water elevations will also rise. As ground water rises, it would likely emerge on the surface of most of King Salmon by 2065 based on the current high sea level rise projections (OPC 2018). Ground water will merge with MHHW at 9.8 feet, creating a flood hazard (Figure 6).

### **Salt Water Intrusion**

Salt water intrusion or inflow can adversely affect groundwater or underground infrastructure such as sewer lines, water lines, wells, electrical pumps, optical fiber lines, and foundations. There are three wastewater lift stations in King Salmon; one could be tidally inundated by MHHW with 0.5 meters (1.6 feet) of sea level rise and another by MHHW with 1.0 meter (3.3 feet) of sea level rise.

### 3.1.2 Adaptation Goals, Strategies and Solutions

The unincorporated community of King Salmon is a mostly built-out environment of residential, commercial, and recreational development. Only 16% of the lots in the community are vacant. Access to the community is by Highway 101 and County-maintained King Salmon Avenue. The County maintains the community streets and drainage. Humboldt Community Services District provides municipal water and wastewater services via underground pipelines, wells, and lift stations. Private companies provide natural gas and communications via underground pipelines and optical fiber lines, and overhead electrical distribution system. Pacific Gas and Electric's regional HBGS and spent nuclear fuel storage facility are also located in King Salmon.

The structural design life of most residential or commercial buildings is approximately 100 years. Within a 100-year period, the amount of sea level rise that this community could be exposed to by 2120 ranges from a high projection of 9.4 feet (2.9 meters) to an extreme projection of 15.0 feet (4.6 meters; OPC 2018) (Table 1). Over the short-term (20 to 45 years), the community is at risk of being tidally inundated by king tides and MMMW tides with 1.6 feet (0.5 meter) of sea level rise, and flooded daily by MHHW with 3.3 feet (1.0 meter) of sea level rise.

#### Adaptation Goals

Sea level rise adaptation goals for King Salmon could include to:

- Maintain access to PG&E's facilities and the community of King Salmon for as long as feasible.
- Maintain energy infrastructure in King Salmon for as long as feasible.
- Protect the critical ISFSI facility from being exposed due to bluff erosion.
- Maintain the use and value of residential, commercial, and recreational developments for as long as feasible.
- Maintain utility services to the community for as long as feasible.
- Maintain coastal access and recreational uses in the community for as long as feasible.

#### Adaptation Strategies and Solutions

Education is an important strategy to address adaptation to sea level rise. In 2018, the County held a community workshop to educate residents, business owners, and the public about King Salmon's vulnerabilities to sea level rise. A series of four County Planning Commission workshops were held to review sea level rise policy options with the Commission. Future County Planning Commission, County Board of Supervisors, and California Coastal Commission public hearings to consider adoption of sea level rise policies for the HBAP will provide additional opportunities for education, obtaining information, and providing public input.



Protection of the community's built-out environment exposed to sea level rise is a high priority short-term strategy. While accommodation solutions are important to pursue when upgrading existing structures, locating future development and structures should be avoided in areas that will need protection from sea level rise. The relocation of existing development, whenever feasible, is a long-term solution for exposure to sea level rise. Adaptation strategies and solutions specific to King Salmon including protection, accommodation, relocation, and avoidance are detailed below.

- Protection Strategies and Solutions

Existing development could be defended or protected from tidal inundation and wave energy erosion through "hard" shoreline structures, such as dikes, sheet piling, sea walls, and other types of bulwarks. Protection could also be provided by moving sea level rise hazards further away from existing development using "soft" shoreline protection such as beach nourishment, barrier dune systems, and living shorelines, to buffer wave action.

1. Elevate King Salmon Avenue.

Elevating King Salmon Avenue could protect access to PG&E's energy facilities, ISFSI and the community of King Salmon from rising seas. With 1.6 feet (0.5 meter) of sea level rise, MAMW or king tides could tidally inundate approximately 950 feet of King Salmon Avenue. With 3.3 feet (1.0 meter) of sea level rise, the entire 2,500 feet (0.5 mile) of roadway would be inundated monthly by MAMW. Raising the elevation of King Salmon Avenue to approximately 12 feet (NAVD 88) would protect access to the community from 3.3 feet (1.0 meter) of sea level rise. Raising the entire length of King Salmon Avenue could serve as a tidal barrier, like a dike, to protect PG&E's facilities. Removing the bridge over King Salmon Canal and filling in the canal to support the roadway would also block tidal inundation from King Salmon Canal, which is also a pathway for flooding PG&E's facilities. Pumping could become necessary to prevent the PG&E's energy facilities from flooding due to stormwater runoff and rising groundwater.

2. Elevate rock revetment and sea wall and/or build a dolo field to protect Buhne Hill and the PG&E ISFSI site.

Existing rock slope protection or revetment is protecting the north facing bluff of Buhne Hill from wave induced erosion. This shoreline is directly across from the bay entrance and is exposed to some of the highest wave energy in Humboldt Bay, a significant concern since the ISFSI is just 115 feet from the bluff face. Water elevations greater than 13 or 14 feet (NAVD 88) will begin to overtop the rock slope protection and access the bluff face. Water elevations equal to or greater than 15 feet (NAVD 88) (MAMW + 6.6 feet [2.0 meters] of sea level rise) will overtop all of the rock shoreline (Figure 4). Under these conditions and potentially sooner, storm waves would be able to erode the bluff and possibly directly impact the ISFSI. Increased protection of the bluff and ISFSI could be achieved by extending the existing rock revetment farther upslope or constructing a new sea wall. Dissipating wave energy and height in front of the rock



shoreline could also be achieved with the installation of concrete dolo structures, like those used on the harbor entrance jetties.

3. Elevate community streets.

With 1.6 feet (0.5 meter) of sea level rise, MAMW or king tides could tidally inundate nearly all community streets. If access to the community is to be maintained, elevating community streets (as suggested for King Salmon Avenue) could offer better protection against tidal inundation from 3.3 feet (1.0 meter) of sea level rise by 2065 (OPC 2018).

4. Build a tidal barrier along the west bank of King Salmon Canal.

Constructing an earthen dike with rock slope protection or sheet piling installed on the west bank of King Salmon Canal could protect the community from tidal inundation. The new tidal barrier structure should begin at the short jetty at the end of Buhne Drive and follow the west bank of King Salmon Canal north, extending to an elevated King Salmon Avenue, which would also function as a dike approximately 2,300 feet in length (Figure 8). The tributary canals, which are pathways for inundation, would become tidally disconnected from the King Salmon Canal. The tributary canals range in width from approximately 75 to 95 feet and could be filled to a surface elevation that would better protect King Salmon from tidal inundation and rising groundwater. These new higher elevation areas could also provide the space for existing structures to be relocated. However, this option would completely change the character of this unique coastal community.



Figure 8. Potential tidal barrier dike structure approximately 2,300 feet in length on the west bank of the King Salmon Canal to protect the community of King Salmon from tidal inundation, and an elevated King Salmon Avenue dike.

##### 5. Build a moveable tidal barrier on King Salmon Canal.

Alternatively, the 2,100 feet of the east bank (an unmaintained earthen dike) of the King Salmon Canal up to the King Salmon Avenue bridge could be enhanced (widened, fortified, and raised) to contain sea level rise to 3.3 feet (1.0 meter). A concrete structure could then be installed between the enhanced dike on the east bank and right bank of King Salmon Canal near Halibut Avenue to house a tide gate or lock structure (Figure 9). The gate or lock would need to be closed when tides rise above a benchmark elevation to prevent flooding of the community.



Figure 9. Potential lock-dike structure approximately 2,100 feet in length on the east bank of the King Salmon Canal, and an elevated King Salmon Avenue dike, to protect the community of King Salmon from tidal inundation.

6. Enhance the tidal barrier on the shoreline south and west of Buhne Drive.

The U.S. Army Corps of Engineers built a rock wall, approximately 1600 feet long, west of Buhne Drive, and back filled the area with sand to protect the community (Figure 10). The rock wall extends out approximately 550 feet into Humboldt Bay as a jetty to protect the barrier dune system constructed on the western shore of King Salmon. With 3.3 feet (1.0 meter) of sea level rise, MAMW or king tides would overtop the existing rock shoreline, providing a pathway for tidal inundation of the community. To continue to function as a barrier to tidal inundation and better protect the community, a dike could



be constructed on the rocky shoreline to contain sea level rise through 3.3 feet (1.0 meter).



Figure 10. Potential location of a rocky shoreline dike structure approximately 1,600 feet in length to better protect community of King Salmon from tidal inundation.

7. Elevate the dune crest between the new shoreline dike and Humboldt Hill.

The jetties protecting the dune barrier system may be overtopped by 2065 with 3.3 feet (1.0 meter) of sea level rise. By 2095, when water levels may reach approximately 15 feet (NAVD 88) with 6.6 feet (2.0 meters) of sea level rise (OPC 2018), the 7.8- acre

dune barrier system may have eroded away and cease to protect the western side of the community from tidal inundation. The rock jetties would need to be elevated and sediment imported to replenish the beach and rebuild the barrier dune system's elevation (Figure 11). Alternatively, a dike or sea wall could be constructed parallel to Buhne Drive to protect the community, but that would likely result in the loss of the barrier dunes and beach.



Figure 11. Location of the barrier dune system (approximately 7.8 acres) that protects the community of King Salmon from tidal inundation, and an alternative dike or sea wall protection.



- Accommodation Strategies and Solutions

Accommodating rising sea levels as a strategy can reduce exposure to flooding (tidal inundation, rising groundwater, and backwater), shoreline erosion, and salt water intrusion in ways that maybe more effective in the long-term than building barriers. Avoiding the full force and energy of waves that can impact land uses, infrastructure, and development is the opposite of erecting barriers to rising water elevations and waves to protect uses and structures. Barrier structures also do not protect low-lying areas from flooding due to rising groundwater or stormwater runoff/backwater; accommodating these types of flooding would be desirable. Accommodating sea level rise while continuing to provide a connection to its coastal waterways would help preserve the uniqueness of the King Salmon community.

1. Community streets and King Salmon Avenue could be rebuilt on elevated causeways above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065. This would allow for an expansion of the bay environment. However, this may not be more economical than building the streets up, like a dike, in phases over time.
2. Individual buildings could be retrofitted or rebuilt on top of pilings over low-lying areas or water at an elevation above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065. Elevating structures, to allow water to pass freely underneath, is a long-established practice on waterfronts. A significant portion of the property in King Salmon is waterfront property. Building residential structures out over water has been done in other areas over lakes, such as Clear Lake (Figure 12) and Lake Tahoe.
3. Rather than elevating each structure, an elevated pier the length of each block (less than 800 feet in length) could be built on both sides of elevated community streets or as a single pier structure (175-185 feet in width) between the tributary canals to support residential, commercial structures, and street access.



Figure 12. A residential community built on pilings over water, which could be applied in King Salmon to accommodate sea level rise in conjunction with elevated streets.

4. Alternatively, on existing lot surfaces or elevated ground surfaces, individual structures could be retrofitted or rebuilt to have a break-away first story (Figure 13) or pilings/posts (Figure 14) with the liveable floor elevation above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065.



Figure 13. Example of a residential structure with a break-away first story and livable second story, recently construction in King Salmon.





Figure 14. An example of an elevated house in Hawaii with liveable floor area above storm surge elevation.

- Relocation Strategies and Solutions

In some cases, relocation of existing land uses and infrastructure may be required due to sea level rise impacts, but ultimately may not be possible. This section addresses primary infrastructure in King Salmon, discusses potential relocation strategies for King Salmon, and identifies core assets that may not be relocatable.

1. Relocating King Salmon Avenue would not avoid the exposure to the sea level rise impacts (tidal inundation, shoreline erosion, and rising groundwater) of the existing location. Even if relocated, King Salmon Avenue would still have to traverse tidally inundated areas if it is to continue to provide vehicular access to PG&E's facilities, particularly the ISFSI, and the community of King Salmon. Protection or accommodation and not relocation of King Salmon Avenue are the more appropriate adaptation strategies.
2. The HBGS is not a coastal-dependent facility. The former Humboldt Bay Power Plant required a coastal location to access cooling water from the Bay, hence the extension of King Salmon Canal to PG&E's property. In the long-term, the recently built HBGS could be relocated from King Salmon to a more secure inland location. No doubt this would be a substantial expense;

- therefore, other adaptation strategies would need to be employed in the short-term.
3. The ISFSI cannot be relocated until the federal government authorizes a new disposal/storage site; therefore, it would need to be protected from wave induced bluff erosion.
  4. Relocating an entire community such as King Salmon would be extremely challenging at best, and probably unrealistic. It is reasonable to consider relocation of individual residences, but relocation of an entire community to an inland location of the County away from the Bay is unlikely. Who would take on the responsibility of relocating a community versus individual developments? Also, King Salmon is a unique bayside community with a system of tidal channels that allow residences to have docks adjacent to their homes. This circumstance could never be recaptured at an inland location. As structures are threatened by tidal inundation, people will eventually decide to move to other communities. Consideration should be given to buying out residential properties to encourage early relocation and avoid costs associated with protecting residential development from sea level rise. Ultimately, there could be a significant issue of abandonment of structures as conditions degrade and opportunities for investment decline.
  5. Some commercial business that are dependent on their location on the shore of Humboldt Bay could relocate to other shoreline areas along the bay, unless similar businesses already occupy these locations. Consideration should be given to buying out commercial properties to encourage early relocation and avoid costs associated with protecting commercial development from sea level rise.

- Avoidance Strategies and Solutions

Updated planning and land use policies together with real estate disclosure requirements that restrict construction of additional structures that would be exposed to sea level rise impacts is a valuable avoidance strategy. This strategy and solution would better manage future development in King Salmon to avoid impact on additional properties and infrastructure. Because most of King Salmon is in the state's retained jurisdiction pursuant to the California Coastal Act, implementing this strategy will be dependent on whether the Coastal Commission denies coastal development permit requests to build or rebuild structures in King Salmon that can accommodate sea level rise greater than 3.3 feet (1.0 meter) (Figure 13). To date, the Commission has allowed development of individual residential lots to proceed that are designed to accommodate sea levels greater than 3.3 feet. Unfortunately, this approach ignores the fact that individual residential developments are dependent on community assets for access and utility services, which presently cannot accommodate 3.3 feet of sea level rise.

1. Amend the HBAP and Coastal Zoning Regulations to prohibit land uses and development that would need to be protected in areas that could be inundated as soon as 2065 with 3.3 feet (1.0 meter) of sea level rise.
2. Require real estate disclosures for all property in areas that could be inundated as soon as 2065 with 3.3 feet (1.0 meter) of sea level rise.
3. Prohibit development with a design life greater than 45 years in areas that will need to be protected from sea level rise of 3.3 feet (1.0 meter) or more.
4. Prohibit rebuilding 50% or more of a structure with a design life greater than 45 years that will need to be protected from sea level rise of 3.3 feet (1.0 meter) or more.

### **3.1.3 Recommended Adaptation Strategies and Solutions**

Engineers, given enough data and time, can design protective and accommodative solutions to sea level rise for most structures and land uses. However, securing capital to build these engineered solutions, let alone acquiring regulatory authorizations, is not necessarily assured. The gulf between developing applicable sea level rise adaptation strategies and solutions, and then actually implementing them, is significant.

The viability of King Salmon Avenue to continue to provide vehicular access is crucial to the future of PG&E's energy facilities and the continued maintenance of the ISFSI, which is critical to the Humboldt Bay region. The preferred adaptation strategy for King Salmon Avenue includes protection for this high-priority nuclear fuel storage infrastructure. This would involve elevating King Salmon Avenue and eliminating the bridge over King Salmon Canal which would form a tidal barrier structure, and would serve a dual function of maintaining vehicular access and protecting PG&E's facilities from tidal inundation.

King Salmon is one of many communities in the unincorporated area of the County that has no organized entity (homeowners association, special district, or municipality) to represent community interests other than the County. The County is responsible for designating land use, and for maintaining roadways that provide access to and within King Salmon and are a critical community asset. Therefore, the County has an important role in sea level rise adaptation planning for this community. King Salmon Avenue, in its present condition, would begin to be tidally inundated by MAMW nuisance flooding with 1.6 feet (0.5 meter) of sea level rise, which could possibly occur by 2040 (OPC 2018). By 2065 with 3.3 feet (1.0 meter) of sea level rise, MHHW would inundate most of King Salmon Avenue daily. If the community of King Salmon is to exist beyond 45 years with maintained access and utility services, adaptation strategies and solutions will need to be developed, permitted, funded, and implemented. This community lacks the capacity, without the County's leadership and involvement, to write proposals and secure grant funding to develop, permit, and implement adaptation strategies and solutions. It is essential that the Coastal Commission join the County in developing and

implementing any adaptation strategy as King Salmon is entirely within the State's retained jurisdiction.

There are at least two general sea level rise adaptation strategies for the community of King Salmon. One strategy would raise the existing low elevation surfaces, and the land uses and development located therein, to protect them from tidal inundation. The other strategy would abandon the existing low elevation surfaces and accommodate rather than resist tidal inundation.

To protect the community of King Salmon from tidal inundation with rising sea levels, it may be necessary to create barriers to the pathways of inundation, specifically from King Salmon Canal and its tributary canals. A 2,300-foot long dike could be constructed along the western bank of the King Salmon Canal across the tributary canals, tying into Buhne Hill and the rock slope protection shoreline west of Buhne Avenue (Figure 8). The 1,600-foot-long rocked shoreline west of Buhne Drive on the south side of the community (Figure 10) would also have to be raised (to a minimum of 12.1 feet NAVD 88) to prevent tidal inundation from sea level rise of 3.3 feet (1.0 meter), the high projection for 2065.

The community streets should be raised to an elevation above projected sea level rise of 4.9 feet (1.5 meters), approximately 14 feet (NAVD 88). Existing undeveloped lots could be raised in elevation to be above the projected sea level rise and groundwater elevations for 2100, 12 feet (NAVD 88). This protection adaptation strategy also affords an opportunity to fill and raise the elevation of the tributary canals that would be blocked off from King Salmon Canal by a barrier dike (Figure 8). These tributary canals range in width from 75 to 95 feet and could provide viable areas for development or relocation of existing structures.

An alternative and perhaps preferable strategy to building protective barrier shoreline structures is to accommodate tidal inundation. This could be achieved by building community structures on pilings above the projected tidal elevations and forgo construction and modification of tidal barrier structures. Other communities have taken similar design approaches and have liveable residential dwellings or commercial buildings built on pilings out over water that allow for inundation of the ground beneath (Figures 12 and 14). New residential structures could also be built on a clear story foundation with the liveable floor above the projected sea level rise for MAMW with 3.3 feet (1.0 meter) of sea level rise (12.1 feet NAVD 88). With either protection or accommodation strategies, the community streets will need to be elevated either by raising the surface of the streets or rebuilding the streets on elevated causeways.

If sea level rise adaptation strategies and solutions are not adopted or implemented in the next 45 years or some time before 2065, the community of King Salmon will likely cease to exist as it becomes tidally inundated daily by MHHW with 3.3 feet (1.0 meter) of sea level rise.



The only viable sea level rise adaptation strategies for PG&E's recently built HBGS facilities includes protection in the short-term from MAMW (12.1 feet NAVD 88) with 3.3 feet (1.0 meter) of sea level rise and eventual relocation over the long-term. PG&E's new power generating facilities are no longer coastally dependent for cooling as were the former nuclear reactors. The power generating facilities could be located inland away from areas that could be tidally inundated by sea level rise. However, the ISFSI nuclear and radioactive materials can only be relocated to a federal depository, of which there are none at this time. The Coastal Commission when issuing a coastal development permit for the ISFSI, stated that the facility would likely be here in perpetuity (2007). Therefore, the nuclear and radioactive materials must be protected from sea level rise exposure due to bluff erosion.

As previously stated, nearly the entire community of King Salmon is in the state's (Coastal Commission) retained jurisdiction. Coastal development permits, required for any development within the Coastal Zone that could impact coastal resources including the implementation of sea level rise adaptation solutions, are issued by the Coastal Commission pursuant to the Coastal Act, not the County pursuant to its LCP. The Coastal Commission's sea level rise guidance principle (CCC 2015) to avoid development or redevelopment in areas that will need to be protected from sea level rise could be problematic to adopting adaptation strategies or solutions to perpetuate the community of King Salmon. Collaboration between the County and the Coastal Commission is necessary to determine the sea level rise threshold for the community of King Salmon and whether viable adaptation strategies and solutions can become feasible implementation measures.

### **3.2 Fields Landing**

Fields Landing is a historical community located west of Highway 101 on approximately 187 acres that was built up around its waterfront and railroad terminal. The residential and commercial areas in the community of Fields Landing are located on approximately 30 acres and are set back from its now mostly vacant waterfront planned and zoned for CDI on Humboldt Bay (Figure 15). However, only 14% of the residential parcels in Fields Landing are vacant.



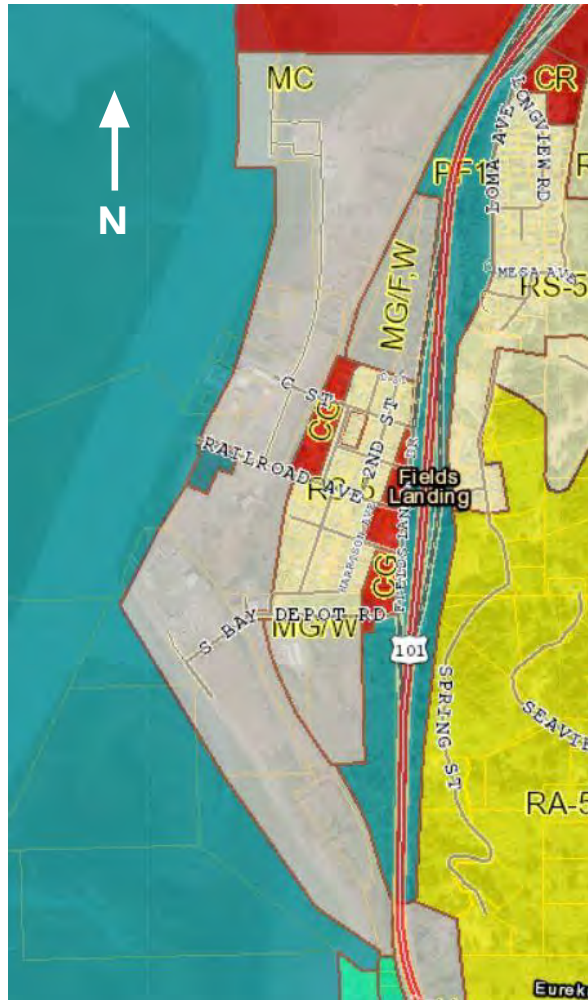




Figure 16. Community of Fields Landing, residential and commercial areas are east of the railroad grade (red line) and coastal dependent industrial areas are along the waterfront.

While the low-lying residential portion of Fields Landing has a surface elevation that ranges from approximately 6 to 8 feet (NAVD 88), its waterfront has a higher surface elevation of approximately 9 to 11 feet. During king tides (MAMW of 8.8 feet), water rises through the storm drains, flooding the surface streets and intersections (Figure 17).



Figure 17. Fields Landing during a recent king tide (MAMW) of 8.8 feet with water rising up through the storm drains and flooding the residential area.

Humboldt County Public Works maintains community streets and stormwater runoff water control structures. Utility service providers include Humboldt Community Services District, which maintains pump stations and a distribution pipe system to deliver municipal water, and sewer lines and lift stations to collect and convey wastewater to the Elk River Wastewater Treatment Plant in Eureka. Pacific Gas & Electric company provides natural gas and electricity to the community. Several private companies maintain communications infrastructure to deliver their services to the community.

The U.S. Army Corps of Engineers maintains the Fields Landing navigational channel to a depth of 30 feet. There is a multi-purpose dock in Fields Landing that was previously used for heavy loading but currently is in poor repair, and a commercial fishing dock that was recently damaged during a fire and may no longer be serviceable. Humboldt County maintains a public boat ramp and parking facilities, and the Harbor District owns and maintains the Fields Landing boat yard with dry dock facilities for commercial and recreational boat repairs. The Harbor District also owns CDI waterfront property. The North Coast Railroad Authority has property and an abandoned railroad grade and water control structures that divide the commercial/industrial waterfront from the residential area of the community. Caltrans maintains Highway 101, including off and on ramps and water control structures, along the eastern boundary of the community.



## Shoreline Erosion

## Tidal Inundation

Primary pathways for tidal inundation of the inland low-lying residential/commercial portion of Fields Landing are where the railroad grade reaches the bay on the north and south end of the community. Inundation via these pathways may occur by 2040 (OPC 2018) with 1.6 feet (0.5 meter) of sea level rise during MMMW of 9.3 feet (NAVD 88) (Figure 18). King tides of 10.4 feet NAVD 88 with 1.6 feet of sea level rise would also breach the waterfront at multiple locations and tidally inundate the low-lying residential and commercial areas to the east (Figure 19). Sea level rise is projected to reach 3.3 feet (1.0 meter) by 2065 (OPC 2018), at which time nearly all developed areas of Fields Landing could be chronically inundated by MMMW of 11.0 feet; Figure 20).



Figure 18. The railroad grade (red line) in Fields Landing provides the primary pathway for tidal inundation of inland, low-lying residential areas by 1.6 feet (0.5 meter) of sea level rise during



MMM of 9.3 feet, assuming shoreline barrier structures do not exist or are breached/overtopped.



Figure 19. Fields Landing's waterfront could potentially be overtopped by king tides (MAMW) of 10.4 feet, with 1.6 feet (0.5 meter) of sea level rise, assuming shoreline barrier structures do not exist or are breached.



Figure 20. Potential inundation of nearly all developed areas in Fields Landing during MMMW of 11.0 feet, with 3.3 feet (1.0 meter) of sea level rise, assuming shoreline barrier structures do not exist or are breached.

### Rising Groundwater and Backwater Flooding

Groundwater elevation likely fluctuates between mean sea level of 3.4 feet (NAVD 88) and MHHW of 6.5 feet (NAVD 88). Most of the residential/commercial area of Fields Landing is 6 to 8 feet (NAVD 88) in elevation. Groundwater could be within 1 to 2 feet of the surface, although in several areas there is open water in the residential portion of the community which indicates groundwater is at the surface. As sea levels rise, groundwater elevation will also rise. Groundwater will likely emerge on the surface of most of the residential/commercial area of Fields Landing by 2040 based on the current high projection for 1.6 feet (0.5 meter) (Figure 21).



Figure 21. Potential rising groundwater flooding in Fields Landing residential area during MHHW of 8.1 feet, with 1.6 feet (0.5 meter) of sea level rise.

### Salt Water Intrusion

Salt water intrusion or inflow can adversely affect groundwater or underground infrastructure such as sewer lines, water lines and wells, electrical pumps, optical fiber lines, septic tanks and leach fields, and foundations. There is one wastewater pump station in Fields Landing (approximately 7.9 feet elevation NAVD 88) that could be flooded by rising groundwater and saltwater intrusion during MHHW with 0.5 meters (1.6 feet) of sea level rise (8.1 feet NAVD 88). Tidal inundation and therefore saltwater



intrusion could also occur during MMMW and MAMW events with 0.5 meters (1.6 feet) of sea level rise (9.3 and 10.4 feet NAVD 88).

### **3.2.2 Adaptation Goals, Strategies and Solutions**

The unincorporated community of Fields Landing is mostly a built-out environment of residential, commercial, and coastal-dependent public facilities. While most of the waterfront is vacant CDI property, only 14% of the residential lots in the community are vacant. Access to the community is by Highway 101 and County-maintained Fields Landing Drive. The County maintains the community streets and drainage. Humboldt Community Services District provides municipal water and wastewater services via underground pipelines, wells, and lift stations. Private companies provide energy and communications services via underground pipelines and optical fiber lines, and overhead electrical distribution system.

The structural design life of most residential or commercial buildings is approximately 100 years. Within a 100-year period, the amount of sea level rise that this community could be exposed to by 2120 ranges from a high projection of 9.4 feet (2.9 meters) to an extreme projection of 15.0 feet (4.6 meters; OPC 2018) (Table 1). Over the short-term (20 to 45 years), the community is at risk of being tidally inundated by king tides and MMMW tides with 1.6 feet (0.5 meter) of sea level rise and perennially inundated by MHHW with 3.3 feet (1.0 meter) of sea level rise.

#### **Adaptation Goals**

Sea level rise adaptation goals for Fields Landing could include to:

- Maintain access for as long as feasible.
- Maintain or relocate the Harbor District's regionally important marine repair facility.
- Maintain the County's Humboldt Bay public boating facilities.
- Sustain the use and value of residential, commercial, public facility and recreational developments for as long as feasible.
- Maintain utility services for as long as feasible.
- Maintain coastal access and recreational uses in the community for as long as feasible.

#### **Adaptation Strategies and Solutions**

Protection of the community's built-out environment exposed to sea level rise is a high priority short-term strategy. While accommodation solutions are important to pursue when upgrading existing structures, locating future development and structures in areas that will need protection from sea level rise should be avoided. The relocation of existing development, whenever feasible, is a long-term solution for the projected exposure to sea level rise. Adaptation strategies and solutions specific to Fields Landing include protection, accommodation, relocation, and avoidance are detailed below.

- Protection Strategies and Solutions

1. Elevate community streets.

Fields Landing Drive off Highway 101 provides access to the Fields Landing community streets. Fields Landing Drive is vulnerable to being tidally inundated when water elevations rise to 12 feet NAVD 88, which could occur from MAMW with 3.3 feet (1.0 meter) of sea level rise. The streets in the residential area of the community range in elevation from 6 to 8 feet and would be vulnerable to frequent flooding should a pathway for tidal inundation develop with 1.6 feet (0.5 meter) of sea level rise during MMMW (9.3 feet NAVD 88). All the streets in the community may need to be elevated to at least the elevation of Fields Landing Drive (12 feet NAVD 88).

2. Build tidal barrier structures.

Existing development can be defended against or protected from tidal inundation and wave energy by “hard” shoreline protection, such as dikes, sheet piling, sea walls, and other types of bulwarks.

Constructing an earthen dike with rock slope protection on or along the railroad grade could protect the community from tidal inundation by 1.6 feet (0.5 meters) of sea level rise. The new tidal barrier structure could also support a 1.3-mile extension of the Humboldt Bay trail (Figure 22). With 3.3 feet of sea level rise, the waterfront would begin to be tidally inundated. A second dike, sea wall, or bulwark could be constructed along 1.7 miles of the waterfront to protect the entire community (Figure 22).





Figure 22. Potential shoreline barriers to tidal inundation along the railroad grade (1.3 miles-red-line) to block inundation pathways by MAMW with 1.6 feet (0.5 meter) and along the waterfront (1.7 miles-yellow line) for 3.3 feet (1.0 meter) of sea level rise or greater.

3. Fill low-lying pathways for tidal inundation.

There are two low-lying areas to the north and south of Fields Landing where the railroad grade reaches the shore of Humboldt Bay. These two relatively narrow shoreline openings that are potential pathways for sea level rise to move inland and tidally inundated the low-lying residential/commercial area of the community (Figure 23). Placing fill in these pathway areas to raise their elevation to at least match the waterfront elevation of 10 feet would form barriers and could in the near-term prevent tidal inundation of the community.



Figure 23. Potential fill barriers (approximately 5 acres in the north and 32 acres in the south to tidal inundation pathways by MMMW with 1.6 feet (0.5 meter) of sea level rise.

- Accommodation Strategies and Solutions

Accommodating rising sea levels as a strategy, as described earlier for King Salmon, can reduce exposure to tidal inundation, rising groundwater flooding, and salt water intrusion in ways that may be more effective in the long-term than building barriers. Like King Salmon, there are a few solutions that could be employed in Fields Landing.

1. Community streets could be rebuilt on elevated causeways above the high projection for MAMW (12.1 feet NAVD 88) with 3.3 feet (1.0 meter) of sea level rise by 2065. However, this may be less economical than building the

streets up in phases over time, which will elevate them above flood levels and will also allow them to function as dikes.

2. Individual buildings in low-lying areas can be retrofitted or rebuilt on top of pilings to an elevation above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065 (12.1 feet NAVD 88).
3. Alternatively, on existing lot surfaces or elevated ground surfaces, individual structures could be retrofitted or rebuilt to have a break-away first story or pilings/posts with the liveable floor elevation above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065.

- Relocation Strategies and Solutions

Due to the low-lying elevations of the residential and commercial areas of Fields Landing and absent implementing protective or accommodation solutions, relocation of existing land uses, developments and infrastructure may be required by 2065 when a sea level rise by 3.3 feet (1.0 meter) (OPC 2018) would result in MHHW inundating the community daily.

1. Coastal-dependent industrial, commercial and recreational developments and uses can be relocated to other higher elevation waterfront locations. Both the County's public boat launch facility and the Harbor District's marine boat repair dry-dock facilities could be relocated elsewhere on Humboldt Bay. The CDI waterfront properties in Fields Landing are generally vacant and the sole bulk cargo dock is not functional and needs repair. Historically, these properties and facilities along with the railroad formed the backbone of Fields Landing, but today they could potentially be considered surplus given the large inventory of vacant or underutilized CDI properties and facilities on Humboldt Bay. Thus, relocation of these CDI uses and developments may not be necessary. The County is in the process of determining which, if any, CDI properties should be planned and zoned for other uses.
2. Generally, it is not realistic to consider relocating an entire community to a new location in the unincorporated area of the County. However, the residential/commercial area of Fields Landing could potentially be relocated within the existing Fields Landing community area. The residential/commercial area covers approximately 38 acres and the adjacent waterfront CDI properties occupy approximately 70 acres. The waterfront properties are higher in elevation than the residential/commercial area and are mostly vacant. The waterfront area could be cleared of existing development, and imported fill placed to raise the surface elevation. There are no environmentally sensitive habitat areas (ESHA) such as wetlands that would be impacted by this solution in the waterfront area, other than the immediate shoreline. The residential/commercial portion of Fields Landing, including the public boat launch, could potentially be relocated to this enhanced waterfront area.

3. Absent such a relocation solution, people will individually eventually decide to move to other communities. Consideration should be given to buying out residential/commercial properties to encourage early relocation to avoid costs associated with protecting residential/commercial development from sea level rise. Ultimately, there could be a significant issue of abandonment of structures in coastal wetlands as conditions degrade and opportunities for investment decline.

- Avoidance Strategies and Solutions

Updated planning and land use policies together with real estate disclosure requirements that restrict the construction of additional structures that would be exposed to sea level rise impacts is a valuable avoidance strategy. This strategy would better manage future development in Fields Landing and avoid additional impacts to properties and infrastructure. Development jurisdiction pursuant to the Coastal Act is split in Fields Landing; the waterfront area is under the state's retained jurisdiction and the residential/commercial area is under the County's permit jurisdiction (Figure 24).



Figure 24. State retained jurisdiction (blue shading) covers most of the waterfront and Coastal Dependent Industrial properties while the County's Local Coastal Program jurisdiction (yellow shading) covers the residential/commercial area.

The County is updating the HBAP, a component of the County's LCP, to address sea level rise exposure through the inclusion of adaptation policies that will guide its land use decisions. The Commission has adopted and revised a general sea level rise policy



guidance document (2015 and 2018) as well as a residential adaptation policy guidance document (2018). Implementing any sea level rise adaptation strategy in a small community like Fields Landing with split jurisdictions will require the County and Coastal Commission to collaborate and coordinate any sea level rise strategies or solutions. Strategies and solutions that could be considered are as follows:

1. Amend the HBAP and Coastal Zoning Ordinance to prohibit land uses and development which would need to be protected in areas that could be inundated as soon as 2065 with 3.3 feet (1.0 meter) of sea level rise.
2. Require real estate disclosures for all property in areas that could be inundated as soon as 2065 with 3.3 feet (1.0 meter) of sea level rise.
3. Prohibit development with a design life greater than 45 years in areas that will need to be protected from sea level rise of 3.3 feet (1.0 meter) or more.
4. Prohibit rebuilding 50% or more of a structure with a design life greater than 45 years that will need to be protected from sea level rise of 3.3 feet (1.0 meter) or more.

### **3.2.3 Recommended Adaptation Strategies and Solutions**

Fields Landing is one of many communities in the unincorporated area of the County that has no organized entity (homeowners association, special district, or municipality) to represent its interests other than the County and HCSD. The County is responsible for designating land use, and for maintaining roadways that provide access to and within Fields Landing and are a critical community asset. Therefore, the County has an important role in sea level rise adaptation planning for this community. Without the implementation of protective solutions by 2040, the streets in Fields Landing, in their present condition, would experience chronic flooding by MHHW and MAMW with 1.6 feet (0.5 meter) of sea level rise. By 2065 with 3.3 feet (1.0 meter) of sea level rise (OPC 2018), MHHW would inundate most of Fields Landing daily. If the community of Fields Landing is to exist beyond 45 years, adaptation strategies and solutions will need to be developed, permitted, funded, and implemented. This community lacks the capacity without the County's leadership and involvement to write proposals and secure grant funding to develop, permit, and implement adaptation strategies and solutions.

There is a simple near-term protection strategy for addressing sea level rise in Fields Landing, and one long-term strategy for the community. Implementation of both adaptation strategies would require the cooperation of the Coastal Commission and County. The near-term protection strategy would be to build a barrier structure (1.3 to 1.7 miles long) to protect the existing low-lying areas, and the land uses and development located therein, from tidal inundation. County streets serving the community would also need to be elevated. However, by 2040 this protection strategy would not address flooding risks to the residential/commercial area from rising groundwater and stormwater runoff. The long-term strategy for Fields Landing would be



for the County to embark on a redevelopment program to relocate the residential/commercial developments of the community (38 acres) to an enhanced and elevated waterfront area (70 acres) that would not be tidally inundated through 2100. The community of Fields Landing is in a unique position in that there is an opportunity to relocate to a safer environment within the community and enhance its waterfront characteristics while adapting to sea level rise.

### **3.3 Fairhaven and Finntown**

The general community area, known as Fairhaven is located on the North Spit on the western shore of Humboldt Bay. Access to the community of Fairhaven is from County maintained New Navy Base Road and Highway 255. Fairhaven was built on a sand dune formation along the shore of Humboldt Bay. Historically, the community was associated with the ship building era of 19<sup>th</sup> century. The community is located east of New Navy Base Road and south of Bay Street. Humboldt Bay's main navigation channel is adjacent to Fairhaven. A former pulp mill, which is now the Fairhaven Business Park with an unused bulk cargo dock and several commercial warehouses, fronts the Bay shoreline in Fairhaven. The extent of the residential area of Fairhaven is Lincoln Avenue to the west, Duprey Street to the south, and Broadway and the Fairhaven Business Part to the east. This residential area is adjacent to undeveloped land designated for industrial use where it does not border the business park (Figure 25). The Samoa Peninsula Fire District Station is located adjacent to this residential area. The residential area relies on individual wastewater septic tank/leachfield systems on lots that range in elevation between 9 and 12 feet NAVD 88.

There is a commercial fishing enclave and residential/commercial development on the north shore of Fairhaven, between Comet and Bay Streets, that historically was referred to as Finntown. This area is nestled between high dunes to the west and the Bay to the east, and has a strong orientation to the Bay with an active marine repair/dry dock facility, aquaculture pier, other commercial uses, and waterfront residential parcels.



Figure 25. The Community of Fairhaven is between New Navy Base Road and the shore of Humboldt Bay. The area historically called Finntown is north of Comet Street (aka Bivalve Way) along the waterfront.

The main residential area of Fairhaven with 65% of its lots undeveloped is bounded on two sides by properties with an Industrial/Coastal-Dependent (MC) land use designation (one of which is zoned Public Facility, the other two zoned MC), the Finntown area is

located in CDI property, and to the northwest is property with an Industrial/General (MG) land use and zoning designation (Figure 26). The MC land south of Park Street adjacent to the residential area and the Bay shoreline contains low-lying seasonal wetlands.

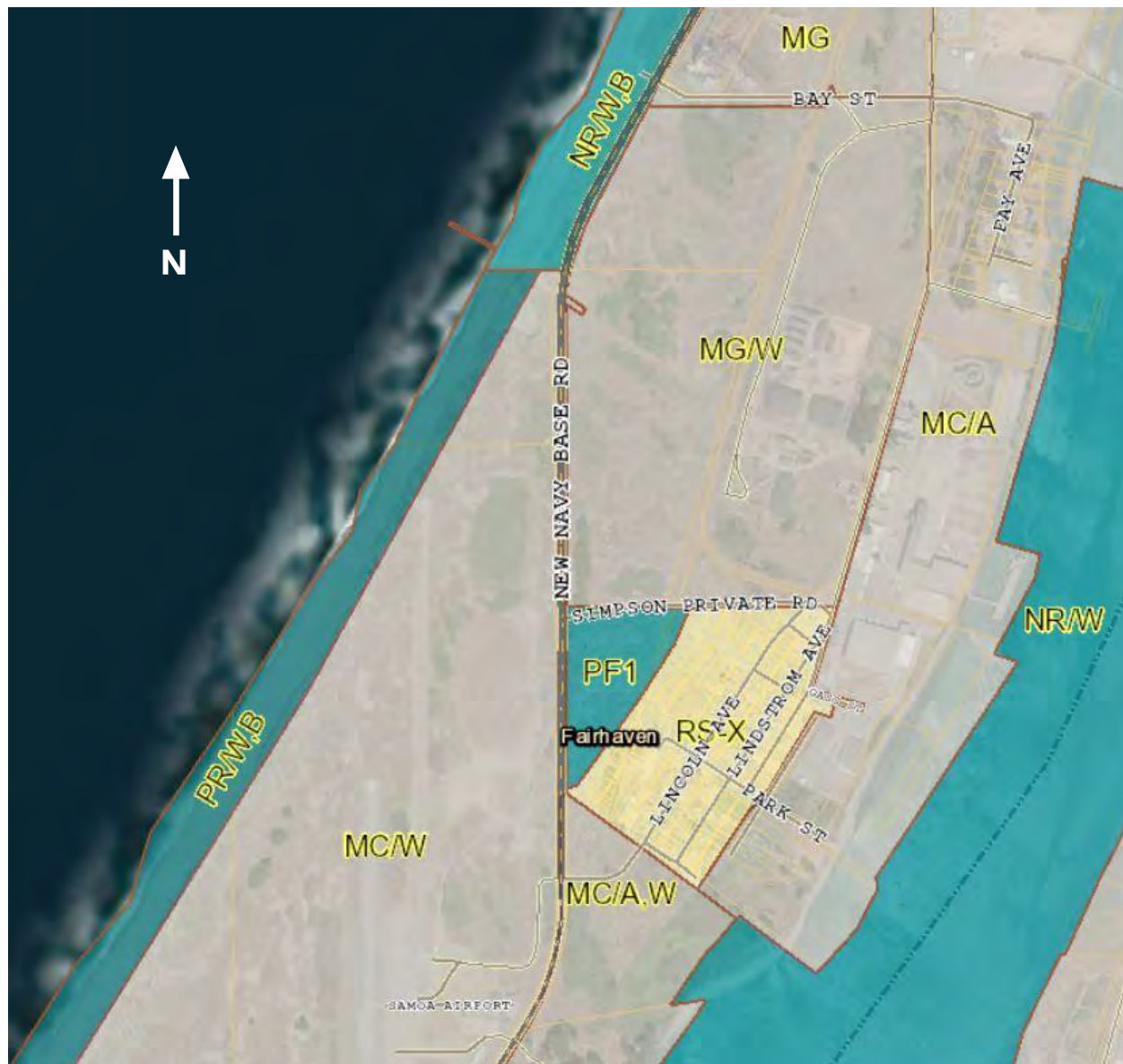


Figure 26. Community of Fairhaven, residential area (RS) (yellow), public facility (PF) (blue), Industrial/General (MG) (grey), and coastal dependent industrial (MC) (grey) zoning. The PF1 parcel is planned MC (Industrial/Coastal-Dependent).

The main residential area of Fairhaven, approximately 37 acres in extent, ranges in elevation from 9 to 12 feet, with low-lying wetland areas (6 to 9 feet in elevation; Figure 27) to the east and south.





0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99





Figure 28. Zerlang's commercial marine boat repair dry dock facility and adjacent waterfront residential developments in Finntown.

### 3.3.1 Sea Level Rise Impacts

The community of Fairhaven and the Finntown area presently are not tidally inundated by king tides (MAMW of 8.8 feet), although groundwater does rise and flood wetlands adjacent to residential area of Fairhaven during these high tide events. The developed residential/commercial areas of Fairhaven and Finntown range in elevation from 9 to 12 feet. By 2065. With 3.3 feet (1.0 meter) of sea level rise (OPC 2018), the community of Fairhaven could be significantly impacted with chronic tidal inundation on a monthly basis, and the Finntown area could experience nuisance tidal inundation approximately 4 times a year.

#### **Shoreline Erosion**

The shoreline along the community of Fairhaven and Finntown area borders the main navigation/shipping channel on Humboldt Bay. The channel is relatively narrow and not exposed to significant wind induced waves or fetch. The southern shoreline segment (0.5 miles long) bordering Fairhaven is approximately 9 to 10 feet in elevation and composed of erodible sand formations, as is evident immediately to the south of the community (Figure 29). Several residential and commercial developments are set-back just 50-150 feet from this erodible shoreline.



Figure 29. Sandy shoreline erosion and retreat just to the south of Fairhaven.

The sandy shoreline south of Fairhaven on North Spit is exposed to reflective waves that bounce off the sea wall in front of the railroad grade across from the entrance to the bay. The shoreline between the U.S. Coast Guard station and Fairhaven is susceptible to shoreline erosion and retreat. The County is continually repairing the shoreline fortifications along New Navy Base Road in this section after major storm events cause wave induced erosion of the shoreline. The 0.5 miles of shoreline along the former pulp property has been fortified with rock and concrete rubble and is generally greater than 14 feet in elevation. The shoreline in Finntown is approximately 0.25 miles long and generally 9 feet or less in elevation. The marine repair dry dock facility has a gently sloping boat ramp up to an elevation of 9 feet. The approximately 500 feet of shoreline in front of the residential area is undeveloped and the next segment 370 feet in length to the north is fortified.

### **Tidal Inundation**

Shorelines less than 10 feet in elevation are highly vulnerable to being overtopped by king tides. Based on California's new sea level rise projections (OPC 2018), the existing



shoreline in Fairhaven and Finntown could begin to be overtopped before 2040. With 1.6 feet (0.5 meter) of sea level rise by 2040, MMMW tides would rise to (9.3 feet), which could result in residential areas east of Lindstrom Avenue being chronically inundated once a month (Figure 30). King tides would rise to 10.4 feet, resulting in the residential areas east of Lincoln Avenue becoming tidally inundated approximately four times a year.



Figure 30. Existing shorelines in Fairhaven and Finntown could be overtopped with 1.6 feet (0.5 meter) of sea level rise combined with a king tide (10.4 feet), assuming shoreline barrier structures do not exist or are breached.

By 2065, with 3.3 feet (1.0 meter) of sea level rise (OPC 2018), MHHW of 9.8 feet (NAVD 88) could inundate these same residential areas east of Lindstrom daily, MMMW could inundate up to Lincoln Avenue, and king tides, which could reach 12.1 feet (NAVD 88), could inundate nearly the entire community, including the Samoa Peninsula Fire District station and Fairhaven Business Park (Figure 31). The undeveloped CDI land south of Fairhaven, most of the CDI lands and former pulp mill property between the southern boundary of Fairhaven (Duprey Street) and Finntown, and virtually all of the Fairhaven/Finntown residential area, would be tidally inundated. Nearly the same area that would be tidally inundated by king tides and 3.3 feet of sea level rise would be inundated daily by MHHW with 4.9 feet (1.5 meters) of sea level rise 11.4 feet (Figure 32).

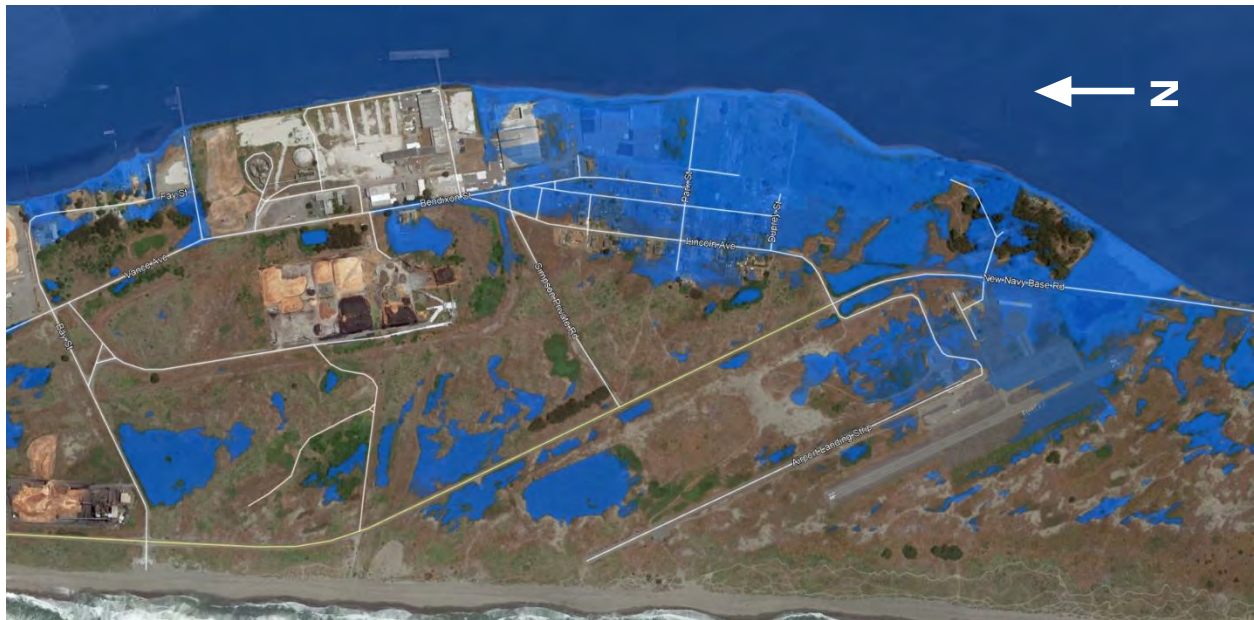


Figure 31. With 3.3 feet (1.0 meter) of sea level rise, king tides could reach 12.1 feet, nearly all of Fairhaven and Finntown could become tidally inundated 4 times a year, assuming shoreline barrier structures do not exist or are breached.



Figure 32. With 4.9 feet (1.5 meter) of sea level rise, MHHW could reach 11.4 feet, nearly all of Fairhaven and Finntown could become tidally inundated daily, assuming shoreline barrier structures do not exist or are breached.

### Rising Groundwater Flooding



Groundwater elevation likely fluctuates between mean sea level of 3.4 feet (NAVD 88) and MHHW of 6.5 feet (NAVD 88). Most of the residential/commercial area of Fairhaven and Finntown is 9 to 12 feet (NAVD 88) in elevation. Thus, groundwater could be within 3 to 6 feet of the surface; for example, there is a low-lying area (6 to 9 feet elevation) between the residential area and the shoreline in Fairhaven (Figure 33) that supports wetland vegetation indicating groundwater is near the surface.



Figure 33. Low-lying areas in and adjacent to Fairhaven (6.5 feet NVAD 88) that are not connected by surface water to the bay.

As sea levels rise, ground water elevation will also rise and will likely affect the septic tank-leachfield systems in most of the residential area of Fairhaven and Finntown by 2040 with 1.6 feet (0.5 meter) of sea level rise (OPC 2018), when MHHW would rise to 8.1 feet (NAVD 88).

### **Salt Water Intrusion**

Like rising groundwater, salt water intrusion can adversely affect underground infrastructure such as waterlines and wells, optical fiber lines, septic tanks and leachfields, and foundations. Salt water intrusion can also contaminate groundwater. As tides rise, salt water intrusion can permeate underground and low-lying areas less than 9.0 feet in elevation interior of the shoreline, even though overtopping of the shoreline has not occurred. By 2040, salt water intrusion could affect underground septic tank-leachfield systems in the area east Lindstrom Avenue in Fairhaven on a daily basis by MHHW with 1.6 feet (0.5 meter) of sea level rise (8.1 feet NAVD 88), even though the shoreline would not be overtopped in this area daily (Figure 34).



Figure 34. Potential areas in Fairhaven where salt water intrusion could occur when MHHW rises to 8.1 feet, with 1.6 feet (0.5 meter) of sea level rise absent shoreline overtopping.

### 3.3.2 Adaptation Goals, Strategies and Solutions

The County maintains New Navy Base Road and the community streets and drainage infrastructure. Humboldt Bay Municipal Water District provides municipal water, and wastewater is processed on an individual basis with septic tank-leachfield systems. A recently approved Samoa Peninsula Community Services District will assume ownership and maintenance of municipal water infrastructure in this community. The District may also pursue extending wastewater infrastructure to Fairhaven and Finntown, which would address the vulnerability of the individual septic tank-leachfield systems to sea level rise. Private companies provide natural gas and communications via underground pipelines and optical fiber lines and provide electricity via an overhead electrical distribution system.

The structural design life of most residential or commercial buildings is approximately 100 years. Within a 100-year period, the amount of sea level rise that this community could be exposed to by 2120 ranges from a high projection of 9.4 feet (2.9 meters) to an extreme projection of 15.0 feet (4.6 meters; OPC 2018) (Table 1). Over the short-term (20 to 45 years), the community of Fairhaven is at risk of being chronically inundated by

king tides and MMMW tides with 1.6 feet (0.5 meter) of sea level rise (2040) and perennially flooded by MHHW with 3.3 feet (1.0 meter) of sea level rise (2065).

### **Adaptation Goals**

Sea level rise adaptation goals for Fairhaven and Finntown could include to:

- Maintain access for as long as feasible.
- Maintain regionally important marine repair facility for as long as feasible.
- Maintain Samoa Peninsula Fire District facilities for as long as feasible.
- Sustain the use and value of residential and commercial developments for as long as feasible.
- Maintain utility services for as long as feasible.
- Maintain coastal access and recreational uses for as long as feasible.

### **Adaptation Strategies and Solutions**

Protection of the community's built-out environment exposed to sea level rise is a high priority short-term strategy. While accommodation solutions are important to pursue when upgrading existing structures, locating future development and structures should be avoided in areas that will need protection from sea level rise. The relocation of existing development, whenever feasible, is a long-term solution for exposure to sea level rise. Adaptation strategies and solutions specific to Fairhaven and Finntown include protection, accommodation, relocation, and avoidance, and are detailed below.

- **Protection Strategies and Solutions**

Existing development can be defended or protected from tidal inundation and wave energy erosion through the use of "hard" shoreline protection such as dikes, sheet piling, sea walls, and other types of bulwarks. Elevating roadways is another protection strategy that can provide continued access; these elevated roadways can also act as tidal barriers in some circumstances.

1. **Elevate community streets.**

The County's New Navy Base Road provides the only access to the Fairhaven and Finntown community streets. Highway 255 is the sole means of access to New Navy Base Road and therefore, indirectly, to Fairhaven and Finntown. There are two segments of Highway 255, one on Indian Island and the other on Woodley Island, that in their present condition could be chronically inundated by MMMW (12.7 feet NAVD 88) and MAMW (13.7 feet NAVD 88) with 4.9 feet (1.5 meters) of sea level rise, thereby blocking access to Fairhaven and other communities on the North Spit. The streets in Fairhaven range in elevation from 8 to approximately 13 feet and would be vulnerable to frequent flooding if the shoreline is overtopped/breached which could start occurring with MMMW and 1.6 feet (0.5 meter) of sea level rise (9.3 feet NAVD 88); all the streets would be inundated daily by king tides (13.7 feet NAVD 88) with 4.9 feet (1.5 meters) of sea level rise. To protect the streets in Fairhaven from being tidally inundated they could



be elevated to at least 14 feet (NAVD 88) to avoid flooding associated with sea level rise. The streets in the Finntown residential/commercial area range in elevation from 11 to approximately 14 feet, and could also be elevated to 14 feet NAVD 88 to avoid sea level rise flooding.

2. Build a tidal barrier to tidal inundation.

Constructing an earthen dike with rock slope protection and living shorelines, approximately 3,990 feet (0.7 miles) long on the shoreline of Humboldt Bay and extending west along Duprey Street to Lincoln Avenue could protect nearly all of Fairhaven from tidal inundation (Figure 35). The tidal barrier structure should begin at the former pulp mill property's elevated shoreline and parallel the shoreline on Humboldt Bay for approximately 2,310 feet and then extend west approximately 1,520 feet, avoiding a coastal wetland and parallel to Duprey Street, to Lincoln Avenue. The dike should be at least 14 feet (NAVD 88) in elevation.

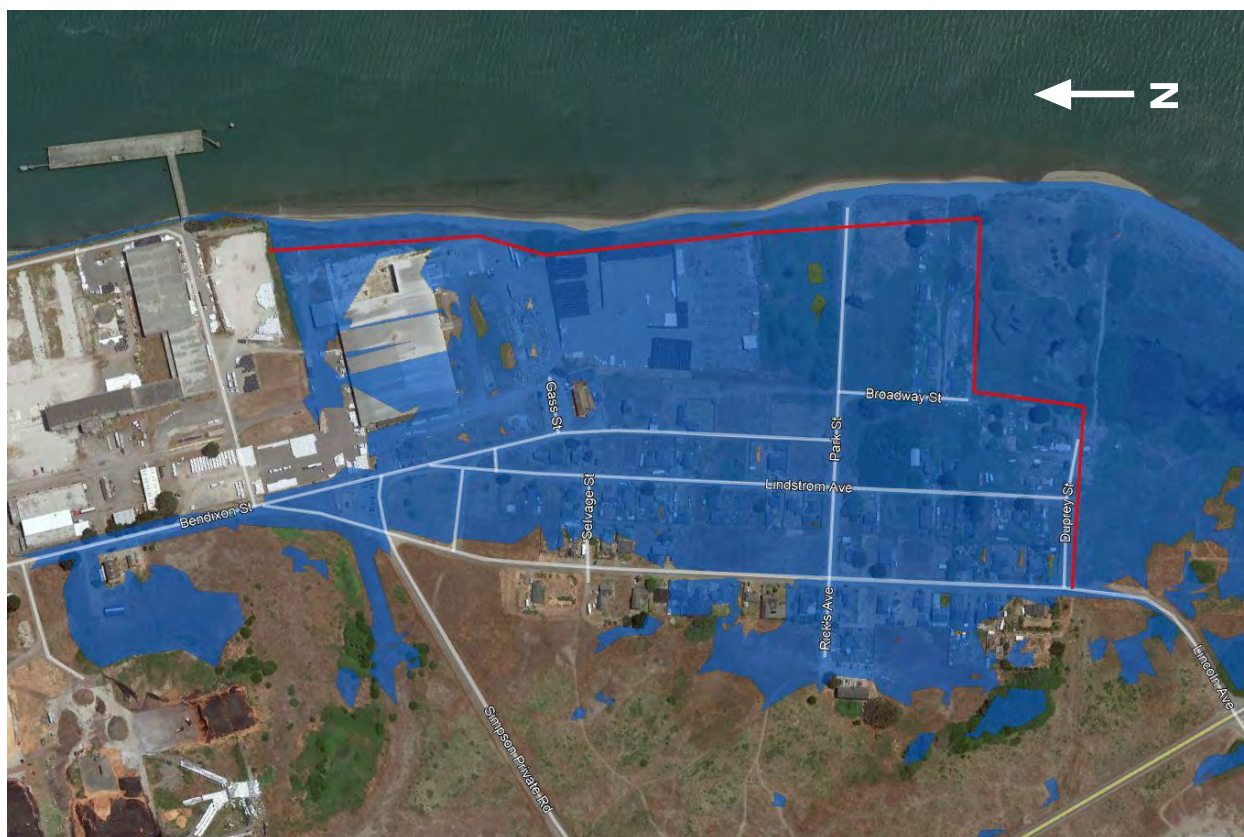


Figure 35. Potential tidal barrier (approximately 3,990 feet long, red) location to protect Fairhaven from tidal inundation, and inundation area by MAMW with 3.3 feet (1.0 meter) of sea level rise,

Alternatively, existing streets such as Bendixon and Broadway (extended to Duprey Street) could be elevated to continue to provide access and to also serve as tidal barrier structures (dikes), thereby providing protection for nearly all of the residentially zoned



property in Fairhaven, excluding the Samoa Peninsula Fire District station and commercial property (Figure 36).

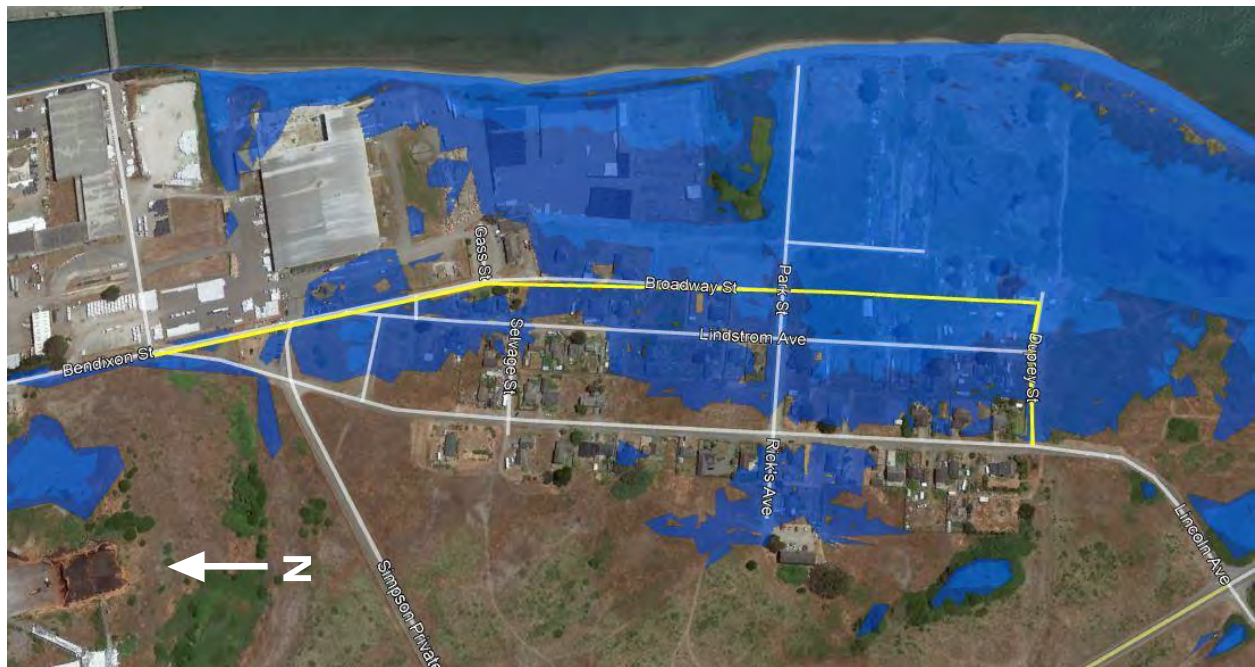


Figure 36. Potential elevated streets/tidal barrier (approximately 3,120 feet long, yellow) locations to protect Fairhaven from tidal inundation, and inundation area by MAMW with 3.3 feet (1.0 meter) of sea level rise

The Finntown area is more difficult to protect if the existing marine repair facility is to be preserved. If the marine facility could be modified to accommodate rising sea levels, a dike approximately 2,060 feet in length could be constructed parallel to the shoreline and around the perimeter of the marine repair facility to fortified shorelines on the north and south (Figure 37).



Figure 37. Potential tidal barrier (approximately 2,060 feet long, red) location to protect residential/commercial areas of Finntown from tidal inundation, and inundation area by MAMW with 3.3 feet (1.0 meter) of sea level rise

- Accommodation Strategies and Solutions

As described earlier, accommodating rising sea levels as a strategy can reduce exposure to flooding and salt water intrusion in ways that maybe more effective in the long-term than building barriers. Similar to King Salmon and Fields Landing, there are a few accommodation solutions that could be employed in Fairhaven and Finntown.

1. Community streets could be rebuilt on elevated causeways above the high projection for MAMW (12.1 feet NAVD 88) with 3.3 feet (1.0 meter) of sea level rise by 2065. However, this may not be more economical than building the roadways up, like a dike, in phases over time.
2. Individual buildings could be retrofitted or rebuilt on top of pilings over low-lying areas to an elevation above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065 (12.1 feet NAVD 88).
3. Alternatively, on existing lot surfaces or elevated ground surfaces, individual structures could be retrofitted or rebuilt to have a break-away first story or

- pilings/posts with the liveable floor elevation above the high projection for MAMW with 3.3 feet (1.0 meter) of sea level rise by 2065 (Figure 13).
4. In Finntown, the marine repair facility dry dock surface could be elevated to accommodate rising water levels while rebuilding necessary support structures on over-water docks.

- Relocation Strategies and Solutions

Due to the low-lying elevations of the residential, public facility and commercial areas of Fairhaven and Finntown, absent implementing protective or accommodation solutions, relocation of existing land uses, developments and infrastructure may be required by 2065 when sea level rise of 3.3 feet (1.0 meter) would result in chronic flooding by MMMW inundating the community on a monthly basis.

1. Coastal-dependent marine boat repair dry-dock facilities and recreational uses could migrate inland with the rising waterfront-shoreline. The marine boat repair dry-dock facilities could also be moved to a new location on Humboldt Bay.
2. Generally, it is not realistic to consider relocating an entire community such as Fairhaven to a new location in the unincorporated area of the County. The residential/public facility area of Fairhaven covers approximately 39 acres. Inland of Lincoln Avenue there are approximately 50 acres of higher elevation land (11.0 + feet NAVD 88) that is mostly undeveloped; a significant portion is zoned Public Facility and owned by the Samoa Peninsula Fire District. It could be possible to relocate the entire residential community of Fairhaven to this area (Figure 38).



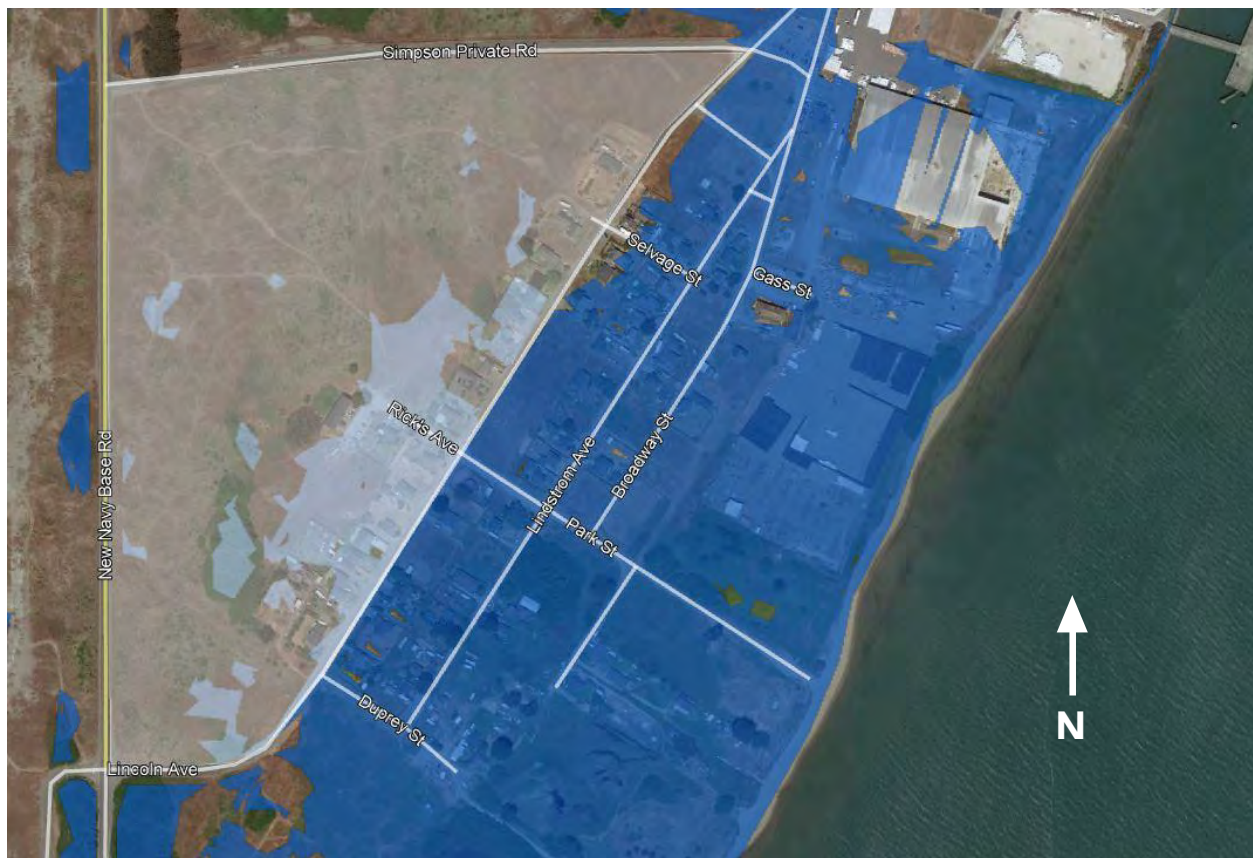


Figure 38. Potential future location for Fairhaven's residential development and public facility between New Navy Base Road and Lincoln Avenue (white), and inundation area by MAMW with 3.3 feet (1.0 meter) of sea level rise,

3. It may also be possible to relocate the residential and noncoastal-dependent commercial developments in Finntown to 13 acres of vacant higher elevation property outside of the potential inundation area for MMMW with 4.9 feet (1.5 meter) of sea level rise too (Figure 39).





Figure 39. Potential future location for Finntown's residential and commercial developments next to Vance Avenue (white), and inundation area by HBMWW with 4.9 feet (1.5 meters) of sea level rise

4. Absent such a relocation solution, people will individually eventually decide to move to other communities. As individual septic systems fail due to rising groundwater and/or salt water intrusion, residential properties may have to be condemned. Consideration should be given to buying out residential/commercial properties to encourage early relocation to avoid costs associated with protecting residential/commercial development from sea level rise. Ultimately, there could be a significant issue of abandonment of structures in coastal wetlands as conditions degrade and opportunities for investment decline.

- Avoidance Strategies and Solutions

Updated planning and land use policies together with real estate disclosure requirements that restrict the construction of additional structures that would be exposed to sea level rise impacts is a valuable avoidance strategy. This strategy would better manage future development in Fairhaven and Finntown and avoid additional impacts to properties and infrastructure. Coastal development permit jurisdiction pursuant to the Coastal Act is split; Finntown is under the state's retained jurisdiction and most of the Fairhaven residential/commercial area is under the County's permit jurisdiction (Figure 40).



Figure 40. State retained jurisdiction (blue shading) covers most of Finntown while the County's Local Coastal Program jurisdiction (yellow shading) covers most of Fairhaven.

### 3.3.3 Recommended Adaptation Strategies and Solutions

Currently, the Fairhaven and Finntown community is one of many communities in the unincorporated area of the County that have no organized entity (homeowners association, special district, or municipality) to represent its interests, other than the County. The newly formed Samoa Peninsula Community Services District could become a local representative of these communities once it is fully organized and operational. The County is responsible for maintaining roadways that provide access, a critical community asset, to and within Fairhaven and Finntown. Therefore, the County has an important role in sea level rise adaptation planning for these communities. Without the implementation of protective solutions by 2040, the streets in Fairhaven east of Lincoln Avenue, in their present condition, would experience chronic flooding by MMMW and MAMW with 1.6 feet (0.5 meter) of sea level rise. By 2065 with 3.3 feet (1.0

meter) of sea level rise (OPC 2018), MHHW would inundate most of these same streets daily, and chronic flooding of streets in Finntown would occur during MMMW and king tides. Before 2065, protective barrier structures (3,990 feet of dike) or elevated roads that function as dikes (3,120 feet) will be necessary to prevent chronic tidal inundation of Fairhaven by 3.3 feet (1.0 meter) of sea level rise during MMMW and king tides. Building tidal inundation barriers will not protect development in these communities without the construction of wastewater treatment infrastructure, as individual septic tank-leachfield systems will likely fail with rising groundwater and saltwater intrusion in response to sea level rise.

If the community of Fairhaven and Finntown area are to exist beyond 45 years with maintained access, a long-term adaptation strategy and solutions will need to be developed, permitted, funded, and implemented. This community lacks the capacity without the County's leadership and involvement to write proposals and secure grant funding to develop, permit, and implement adaptation strategies and solutions.

There is one long-term strategy for the community of Fairhaven and Finntown area; the Samoa Peninsula Community Services District and County could embark on a redevelopment program to relocate the residential/commercial developments of the community (39 and 11 acres) to vacant inland areas (50 and 13 acres) that would not be tidally inundated through 2100. The communities of Fairhaven and Finntown area are unique on Humboldt Bay in that there are opportunities to relocate to a safer environment in response to sea level rise.



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